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PHYSICAL MEASUREMENTS

AND THEIR

APPLICATION IN

DESCRIBING WOOL



Marketing Research Report No. 256

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Marketing Service • Livestock Division

This study is a continuation of work published as Marketing Research Report No. 211, issued February 1958, entitled, "Value-Determining Physical Properties and Characteristics of Domestic Wools."

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ACKNOWLEDGMENTS

The study reported in this publication was a joint undertaking conducted by the Commodity Stabilization Service and the Agricultural Marketing Service. The participation of the many persons in the wool industry and others who cooperated in this work is gratefully acknowledged.

July 1958

Washington, D. C.

Mention of commercial products in this publication does not imply endorsement by the U. S. Department of Agriculture.

SUMMARY

The purpose of this study was to show the use of physical measurements in describing domestic wool.

In order to accomplish this aim 21 lots of domestic wool were processed into top. Samples of grease wool, scoured wool, card sliver, carding and combing wastes, noil and top were drawn as the lots were processed. Such physical characteristics as fineness, length, staple crimp, yield, and color were tested and their application in the description and appraisal of wool studied.

Among the observations made after concluding these examinations were the following:

(1) The effect of skirting on the fineness or the grade of wool top was not consistent from lot to lot or grade to grade; however, there was a tendency for the skirted top to be slightly finer and somewhat more uniform in fiber fineness than the unskirted top; the removal of skirts from fleeces did not appear to influence the fiber length, the yield, and the color of the top, nor the percent noilage.

(2) The use of the proposed standard specifications for grades of grease wool, applied to core samples, and the application of length testing methods were found to be more consistent and precise methods of describing fineness and length than the visual methods employed in this study.

(3) The percent stretch of grease wool staples appears to be more closely associated with the normal length of the grease wool than with its fineness ($r = -.56$; $r = -.33$).

(4) Studies on crimp confirmed the general observation that crimpiness decreased as grade became coarser; coefficient of correlation values indicated that the number of crimps per inch was more highly related to fineness than to length ($r = -.95$; $r = -.83$).

(5) Crimp type index, a numerical value used to indicate or measure the distinctness and prominence of crimp boldness within a lot, appeared to be related to length to a higher degree than to fineness or crimp-per-inch data ($r = .71$; $r = .59$; and $r = -.56$).

(6) There was a very high relationship between top-noil-waste yields and yield determinations based on the 1-1/4-inch core sample ($r = .99$).

(7) Impurities carried by the grease wool were the most important single factor influencing yield; however, comparisons of top-noil-waste yield, top yields, and yield estimates based on the 1-1/4-inch core sample, with the various physical properties and characteristics of the wool revealed that higher yields were usually obtained from the coarser and longer wools than from the finer and shorter wools.

(8) There were strong indications that the incidence of clean wool appearing in the wastes (excluding ~~wool~~) was primarily controlled by the carding and combing machinery rather than by the characteristics of the wool being processed.

(9) The miscellaneous vegetable matter in grease wool seemed to follow through into top to a higher degree than did the kinds of burrs contained in the lots tested.

(10) Coefficient of correlation values indicated that crimp type index, fineness, and length were more closely associated with percent noilage than were the other physical properties tested ($r = -.74$; $r = -.72$; and $r = -.71$).

(11) Color ratings obtained on the scoured core samples appeared to be reliable indicators of the color ratings that could be expected for the lots in the scoured wool, card sliver, and top stages.

PHYSICAL MEASUREMENTS AND THE IR
APPLICATION IN DESCRIBING WOOL

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INTRODUCTION

Wool has certain distinguishing physical properties and characteristics that are measurable and which can be expressed in such customary units as pounds, percentages, inches, or microns, and from which statistical indices may be derived for still wider application. Various segments of the wool industry have indicated a great deal of interest in the application of objective methods for evaluating the physical properties of the commodity.

In order to investigate the use of physical measurement in describing domestic wool, the Denver Wool Laboratory had 21 lots processed into top. Samples of grease wool, scoured wool, card sliver, carding and combing wastes, noil and top were drawn as the lots were being processed. These samples were later measured for such physical characteristics as fineness, length, staple crimp, yield, and color. The results of these tests and their application in the description and appraisal of wool are given in this report.

A report on value-determining physical properties and characteristics of domestic wools was recently published (17) 2/. Included in the report were data resulting from the sampling, testing, and mill processing of 46 lots of Commodity Credit Corporation wool of various grades and from major geographical areas of production in the United States. Studies of these wools, acquired under the Government price support programs during 1952 and 1953, were made to determine the accuracy of visual appraisals for fiber fineness, staple length, and shrinkage. At the same time, an investigation was made of the adequacy of sampling and testing methods and techniques used for the evaluation, assessment, and development of standards for various wool fiber properties.

Work of this general nature has been reported by seven state agricultural experiment stations and other agencies cooperating in the joint Federal-State project, WM-23--Marketing Western Wool. Some articles and reports of results relating to these projects and to similar wool work have been published (8), (9), (14), (24), (25), and (26).

1/ Wool Laboratory, Standardization Branch, Denver, Colorado

2/ Underscored numbers in parentheses refer to literature cited, page 33.

The study on which this report is based was recommended by the Sheep and Wool Research and Marketing Advisory Committee. It is a continuation of the earlier work and utilized an additional 21 lots of CCC wools of various grades and from different geographical areas of production. Its additional purposes were (1) to study the application of the Department's proposed standards for grades of grease wool, (2) to develop adequate staple length guides for wools of various fineness grades, and (3) to develop useful information on other quality characteristics and methods of preparing wool relating to the various wool sampling and marketing practices which are involved in the testing, processing, and distribution of domestic wool.

The sampling and testing of the wools, and the analysis of the results were conducted by the Livestock Division Wool Laboratory (LDWL), Denver, Colorado.

MATERIAL AND METHODS

Wools

Twenty-one lots of wool acquired under price support programs of the Commodity Credit Corporation during 1952, 1953, and 1954 and comprising approximately 290,000 pounds of grease wool were processed into wool top. Description of the lots was as follows:

Lot number	CCC grade classification	Origin	Clip year
4-800-A1	I-A1, Fine, 64s and finer	California	1954
12100-1B	IV-A1, Fine, 64s and finer	Michigan	1954
4-1923-A2	I-A2, Fine, 64s and finer	California	1954
M217	III-A1, Fine, 64s and finer original bag	Texas	1954
Mc3-H2X	III-A2, Fine, 64s and finer original bag	Texas	1954
N-593	III-A4, Fine, 64s and finer original bag	Texas	1954
4-1658-B	I-B1, 1/2 blood, 60s and finer	California	1954
G-516-1/2	do	Idaho	1953
2-NC	do	Nevada	1954
2DB	do	South Dakota	1954
4200-C	I-C1, 3/8 blood, 56/58s	California	1954
4UC	do	Colorado	1954
16860	do	Idaho	1954
93497	IV-C1, 3/8 blood, 56/58s	New York	1954
113006	I-D1, 1/4 blood, 48/50s	Wyoming	1954
93494	IV-D1, 1/4 blood, 48/50s	New York	1954
93498	IV-D2, 1/4 blood, 48/50s	New York	1954
1014	I-E1, Low 1/4 blood, 46s	Idaho	1952
93504	IV-E1, Low 1/4 blood, 46s	New York	1954
124015	IV-E1, Low 1/4 blood, 46s	Virginia	1954
1200F	I-F1, Common and braid, 44, 40, and 36s	California	1953

Preparation, Sampling and Processing

The various stages of preparation, sampling, and processing for the lots of wool in this study are portrayed by the flow chart, figure 1.

Weights.--The bags of grease wool were weighed at the time of delivery at the mill. As the bags were weighed, the even numbered bags were separated from the odd numbered bags. The fleeces of the even numbered bags were to be commercially skirted and processed into wool top (skirted portion), and the fleeces of the odd numbered bags were to be processed into wool top in their original unskirted state (unskirted portion). The average lot weight was approximately 14,000 pounds, grease basis.

The scoured wool, card sliver, top, noil, and all wastes and samples of these products drawn for testing and analysis were weighed as processing progressed.

Sampling of grease wool.--Bags selected at random from each of the unskirted portions of the lots were sampled to obtain grease wool staples for length and crimp testing and cores for yield and fineness determination.

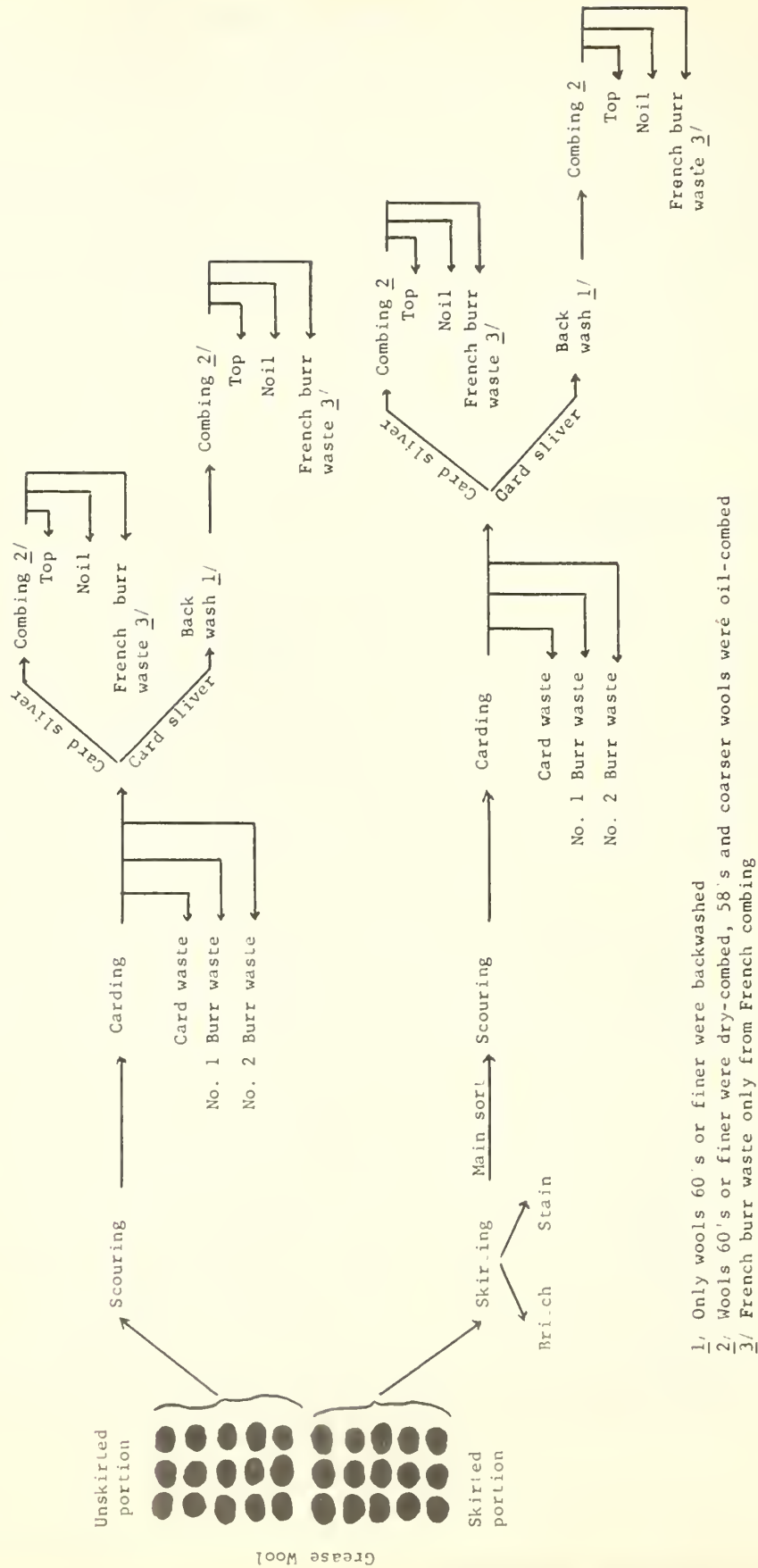
Staples of grease wool were drawn with a wool sampling tool from the bags laid down for coring. This tool is essentially a thin steel rod with half-arrow tip for extracting staples of wool from the bag. An illustration and a more detailed description of it appear in publications (11) and (17). Those publications also give a complete schedule of the number of staples to be drawn, depending on the size of the lot and the accuracy of representation desired. For the lots classified as 64s and finer and 60s and finer, 14 bags per lot were sampled and 5 staples were drawn from each bag. For the lots 56/58s and coarser, 20 bags per lot were sampled and 6 staples were drawn from each bag.

For core sampling the 1-1/4-inch coring tube was used. The core sampling techniques and equipment used were based on information and coring schedules in publications (5), (17), and (23). Five or more cores were drawn per bag. The number of bags cored per lot varied with the number of bags in the unskirted portion; however, a minimum of 100 cores was drawn from each lot.

Preparation of grease wool for processing.--After a lot was weighed, stapled, and cored, the bags were taken to the sorting room.

At this stage for the wools of the unskirted portion of the lot, the fleece strings were removed and the wools were put into bins to await the opening and scouring operations. These fleeces were not skirted, being intended for processing in their original graded condition.

However, for the skirted portion of the lot, the fleece strings were removed and the fleeces were skirted. Two sorts were made from the skirts. One was the coarser britch wool sort and the other the stained wool sort.



- 1/ Only wools 60's or finer were backwashed
 2/ Wools 60's or finer were dry-combed, 58's and coarser wools were oil-combed
 3/ French burr waste only from French combing

Figure 1.--Flow chart of preparation, sampling, and processing stages for lots of wool in this study.

After skirting, the wools were put into bins to await the next stage in processing.

Random samples of the britch and stained wool were collected for fineness and color determinations. These samples varied from 2-1/2 to 10 pounds, depending on the quantity of the sort.

Processing.--The wools of the 21 lots under study were made into wool top at the Abbot Worsted Company, Forge Village, Massachusetts. The opening, scouring, carding, and combing procedures were those normally used by the mill. The wools 64s and finer and 60s and finer were backwashed and dry combed. These included eight lots which were French combed and two lots which were Noble combed. The remaining 11 lots of the grades 56/58s or coarser were not backwashed and were oil-combed on Noble combs.

Sampling of processed products.--Samples of mill products were taken for fineness, length, yield, and color determinations. Random samples were collected at regular intervals during processing. All samples that were to be used for yield determinations were placed in air-tight containers.

The procedures employed in sampling the mill products followed rather closely those detailed in the earlier study of 46 lots of domestic wools (17). The samples obtained, in the current study, for each of the 21 lots were:

Scoured wool - For yield and color, random handfuls from all areas of the storage bins; total 10 pounds.

Card sliver - For yield and color, sections of sliver, each about 2 feet in length; total 5 pounds.

Top - For yield and color, sections of sliver, each about 2 feet in length; total 100 pieces.

Top - For fineness and length, 5 samples of sliver, selected at random, each approximately 12 feet long.

Noils - For yield, random handfuls from bins; total 2 pounds.

Carding wastes - For yield; 1 pound.

Combing wastes - For yield; 1 pound.

Testing

Fineness.--The techniques used in measuring fineness followed the USDA method of test for grades of wool top (21), and the procedures outlined in the reports (1) and (2).

The determination of grade of wool top was based on the official standards of the United States for grades of wool top (20). The determination of the grades of grease wool and the grades of the wools skirted from the fleeces was based on the proposed standards for grades of grease wool, as published in 1955 (22).

Interpretation of fineness test results.--In the interpretation of the grade of top and grade of other products reported in this study an approach has been used which is in line with much of the trade practice. For instance,

in many cases a split grade classification was used. Interpretations of this type of grade designation are detailed in two reports (1) and (17).

Briefly, the first step was to designate the grade within which the average fiber diameter fell, and the second was to designate the finest grade to which the fiber distribution conformed. If both average diameter and distribution met the requirements for the same grade, a single grade classification was designated; otherwise a split grade classification was used.

Length.--The measurement techniques used for determining grease wool staple length and fiber length of wool tops were similar to those described in publications (3), (6), (11), (16), and (17).

The percent stretch of the grease wool staples was determined by the following formula:

$$\text{percent stretch} = \frac{\text{stretched staple length} - \text{normal staple length}}{\text{normal staple length}} \times 100$$

Staple crimp.--The methods used for determining the number of crimps per inch and the crimp type are discussed in the report detailing the crimp measurements of staples drawn from 46 lots of domestic wool (17).

Crimp type index was obtained by designating "bold" crimp type as the numerical value 3, "intermediate" crimp type as 2 and "dim" crimp type as 1. The percentage observed within each crimp type was multiplied by the numerical value of the crimp type, and the sum was the crimp type index.

Yield.--The techniques used for testing core samples of grease wool for clean yield determination followed closely the procedures outlined in (4), (12), and (19).

The method to determine the quantity and types of vegetable material in grease wool is set forth in the publication (13).

The testing procedure used to determine the clean yield of mill products was similar to that described in (7).

All samples were tested for moisture, ash, vegetable matter, and grease content after which the weights were adjusted to the standard condition of 14 percent non-wool components (12 percent moisture, 1.5 percent extractables and 0.5 percent ash).

The adjustment factors thus determined were applied to the actual weight of the products to arrive at an adjusted product weight. The adjusted product weight was divided by the original weight of the lot of grease wool to calculate the clean yield percentage for the particular product.

Color.--Physical color measurements of the wool top samples of this study were made by the Western Utilization Research and Development Division,

Agricultural Research Service, Albany, California, and the techniques used are described in the publication (15). These samples and those of 46 other lots previously processed, together with the visual color ratings made by LDWL, were used in the development of the color comparator also reported in the publication (15).

The wool color comparator has five physical examples of known Hunter color measurement specifications. The whitest example is designated as A, the next whitest as B, and so on through the color class E. Estimates of color are made by comparing the test sample of approximately 10 grams of wool with the physical examples and assigning them color ratings by visual judgment.

Some preliminary treatment of the samples was necessary before the color readings could be made. The samples of the 1-1/4-inch grease wool cores, the samples of the britch and stained sorts that had been scoured, and samples from the mill scoured wools were all rinsed in carbon tetrachloride and blended by hand carding before color estimates were attempted. The samples of the card sliver were also rinsed in carbon tetrachloride but were not recorded.

FINENESS

The results of fineness testing on samples of 1-1/4-inch cores, britch and stained wool, and top from the skirted and unskirted portions of the lots are given in table 1. ^{3/} The specific values pertaining to fineness listed in this table are CCC grade classification, grade by test, average fiber diameter, standard deviation, coefficient of variation, and fiber distribution. Additional data shown are the percentage of britch and stained wools skirted from the fleeces of the skirted portions of the lots.

Appraisal Grade Classification

The CCC grade classifications made by visual appraisal are presented in table 1.

Comparison of Visual Appraisal Grade of Grease Wool With Grade of Top and Grade of Grease Wool Determined by Sampling and Testing Procedures

Individual lot comparisons can be made by referring to table 1. In this connection, however, it should be understood that while the grades are comparable within wide interpretation limits, they are not precisely comparable. That is, the CCC grade classification nomenclature and visual appraisal methods were based on the blood or American grade system in conjunction with a combination of usually two or more grades of the count or numerical systems, and on wool standards under which no physical grade measurements were specified. The top and grease wool grades, however, are based on specific grade standards using the numerical or count system.

^{3/} All tables are grouped in the appendix at the end of this report and hereafter will be referred to only by table number.

Lots visually classified as fine, 64s and finer.--Six lots were of this classification. Three of the lots were graded wools and three were Texas original bag wools. The grades of the top combed from the skirted wool portion of the lots were: one lot grade 70s, four lots grade 64s, and one lot grade 62s.

The grades of top produced from the unskirted wool portion of the lots were: one lot grade 70/64s, three lots grade 64s, and two lots grade 62s. It will be noted that one lot was graded a 70/64s. In this case and as explained under grade determination of the materials and methods section, the grade designation differs from the interpretation of standards for wool top in that a split grade classification was used. Here the first numerical grade designates the grade within which the average fiber diameter fell, and the second numerical grade designates the finest grade to which the fiber distribution conformed.

The grades of the grease wool based on testing the 1-1/4-inch core sample from the unskirted wool portion of the lot were: four lots grade 64s and two lots grade 62s.

Lots visually classified as 1/2 blood, 60s and finer.--Four lots were of this classification. Grades of top from skirted wool portion were: one lot grade 60/62s, one lot grade 60s, and two lots grade 58s.

The grades of top from the unskirted wool portion were: one lot grade 60/62s, one lot grade 60s, and two lots grade 58s.

The grades of the grease wool were: one lot grade 62s, two lots grade 60s, and one lot grade 58s.

Lots visually classified as 3/8 blood, 56/58s.--In this classification there were four lots. For the skirted wool portion the grades of top were: one lot grade 58s, two lots grade 56s, and one lot grade 56/54s.

For the unskirted wool portion the grades of top were: two lots grade 58s and two lots grade 54s.

For the grease wool the grades were: one lot each of the grades 58s, 58/56s, 56s, and 56/54s.

Lots visually classified as 1/4 blood, 48/50s.--There were three lots of this grade classification. The grades of top made from the skirted wool portion of the lots were: one lot grade 54s, one lot grade 50/48s, and one lot grade 48s. The grade 54s as such is not included in the CCC grade classification nomenclature. In fineness 54s falls between the grades 56s and 50s, and in the trade 54s is considered as being a 1/4-blood grade.

The grades of top produced from the unskirted wool portion of the lots were: one lot grade 54s, one lot grade 48/50s, and one lot grade 46/48s.

The grades of grease wool based on testing the 1-1/4-inch cores from the unskirted wool portion were: one lot grade 54s, one lot grade 50s, and one lot grade 48s.

Lots visually classified as low 1/4 blood, 46s.--Three lots were of this classification. The grades of top from the skirted wool portion were: one lot grade 50/48s and two lots grade 46/48s.

The grades of top from the unskirted wool portion were: one lot each of the grades 48s, 44/46s, and 44s.

The grades of grease wool from the unskirted wool portion were: one lot each of the grades 50/48s, 46s, and 44s.

Lot visually classified as common and braid, 44, 40 and 36s.--For the one lot of this classification the grade of top combed from the skirted wool portion was 48s and the grade of top from the unskirted wool portion was 46s. The grade of grease wool was 48s.

All things considered, and on the basis of the foregoing, it would appear that the grade classifications made by visual appraisal were in good order.

The Influence of Skirting Fleeces on The Grade or Fineness of Wool Top

To test the influence of skirting on the grade or fineness of wool top, the lots were divided into two portions of approximately equal size. The fleeces of one portion were skirted and the skirted wools were processed into top. The remaining portions of the lots were processed in their original graded condition and served as a check on the skirted lot portions.

Skirting is a practice of removing the inferior wools from whole fleeces. Two sorts were made from the wools skirted from the fleeces of this study. One sort was the coarser britch wool that comes from the rear end of the sheep and included the tags or dung locks. The other sort consisted of the deeply stained wool.

In the discussion that follows the terms "skirted top" and "unskirted top" are used. The skirted top is the top made from the skirted wool portion and the unskirted top is that made from the unskirted wool portion of the lot.

Percentages of wools skirted from fleeces.--The percentages of britch and stained wool skirted from the fleeces are shown by lot in table 1. These percentages are based on grease wool weights. The amount of wool skirted varied from lot to lot. For the most part, however, a greater percentage of wool was removed from the fleeces of the coarser grades than from those of the finer grades. A summary of the percentages of wool skirted from the fleeces, by visual grade classification, is as shown on page 10.

Visual grade classification	Number of lots	Percentage of britch and stained wool removed from fleeces, based on grease wool weights:			
		Britch		Stained	
		Average percentage	Range percentage	Average percentage	Range percentage
64s and finer	6	1.24	0.00-2.69	0.31	0.00-0.86
60s and finer	4	1.68	0.19-2.69	0.56	0.09-1.46
56/58s	4	0.54	0.19-1.50	1.73	0.13-5.32
48/50s	3	0.71	0.30-1.08	3.20	1.23-4.59
46s	3	2.00	1.10-2.84	2.38	1.80-2.83
44,40 and 36s	1	1.17	-	0.54	-

Grades of wools skirted from fleeces.--The fineness and grade testing data for the britch and stained wool are tabulated in table 1. Comparisons between the fiber fineness of the 1-1/4-inch cores (which represent the grease wool of the unskirted lot portions) and the fineness of the britch and stained wools revealed: the average fiber diameter of the britch wool was greater and in most cases more variable than that of the grease wool from the unskirted fleeces. With a few exceptions a similar relationship existed between the average fiber diameter of the stained wool and the grease wool from the unskirted fleeces.

In most cases the tests revealed that the average diameter of wools from the britch sort was greater than that of wools from the stained sort for the same lot. However, an appreciable increase in fiber diameter variability of the britch wool over the stained wool was not noted. This emphasizes the conglomeration of wools going into the stained sorts.

On the basis of the test data the britch and stained sorts were from one to five numerical grades coarser than the grease wool of the unskirted portion in all lots but three. Exceptions were: the grease wool and stained wool of lot 4-1923-A2 were of the same grade, a 62s; the grease wool and britch wool of lot M217 were of the same grade, a 64s; and the stained wool of lot Mc3-H2X was a grade 70s and the grease wool of this lot was a grade 64s.

The effect of skirting on grade of top.--In light of the amount and fineness of the britch and stained wools removed from the fleeces, it is interesting to note, by referring to table 1, the result skirting had on the grade of top of the individual lots.

As pointed out previously, the grades of top as listed in table 1 were occasionally expressed by using a split grade classification. That is, if the average fiber diameter and fiber distribution values do not meet the specifications of the same grade, the grade classification is made by first designating the grade within which the average fiber diameter fell and then designating the finest grade to which the fiber distribution conformed, resulting in a split grade classification such as 64/62s.

To simplify the comparison between the grades of skirted and unskirted top the guides used to determine grade were: for example, if both the fiber diameter and fiber distribution conformed to grade 60s, the grade was called a 60s; if the average fiber diameter conformed to grade 60s and the fiber distribution was uniform enough to meet a 62s grade, the grade was also called a 60s; if, however, the average fiber diameter conformed to a 60s grade and the fiber diameters were so variable that they would not meet a 58s grade, the grade was called a 58s, thus avoiding the split grade classification. The following summary compares the grades of skirted and unskirted top by visual grade classification:

Visual grade classification	Number of lots	Number of lots in which the following occurred:		
		Grade of skirted and unskirted top identical	Grade of skirted top one numerical grade finer than unskirted top	Grade of skirted top one numerical grade coarser than unskirted top
64s and finer	6	4	2	
60s and finer	4	4		
56/58s	4	2	1	1
48/50s	3	2	1	
46s	3	1	2	
44, 40 and 36s	$\frac{1}{1}$		$\frac{1}{1}$	
Total	21	$\overline{13}$	$\overline{7}$	$\overline{1}$

The grade of the skirted and unskirted top was identical for 13 of the 21 lots. The grade of the skirted top was one numerical grade finer than the grade of the unskirted top for 7 of the 21 lots, and the grade of the skirted top was one grade coarser than the grade of the unskirted top for 1 lot of the 21.

The effect of skirting on average fiber diameter and fiber distribution of top.--The specific fineness testing data such as average fiber diameter, standard deviation, coefficient of variation, and fiber distribution for the skirted and unskirted top samples are given by lot in table 1.

The graphic chart in figure 2 and the values listed in table 1 indicating the influence of skirting fleeces on the average fiber diameter of top show that in 17 of the 21 lots the average fiber diameter of the skirted top was less (finer) than that of the unskirted top: the difference ranged from 0.04 micron to 1.17 microns. In the remaining four lots, the average fiber diameter of the skirted tops was greater (coarser) than that of the unskirted top: the difference ranged from 0.12 to 0.70 micron.

The coefficient of variation values for the skirted top were not as great as the coefficient of variation values for the unskirted top in 13 of the 21 lots. Also, for the skirted top, the percentage of the fibers in the maximum micron groups of fiber distribution was slightly lower than for the unskirted top in 16 of the 21 lots.

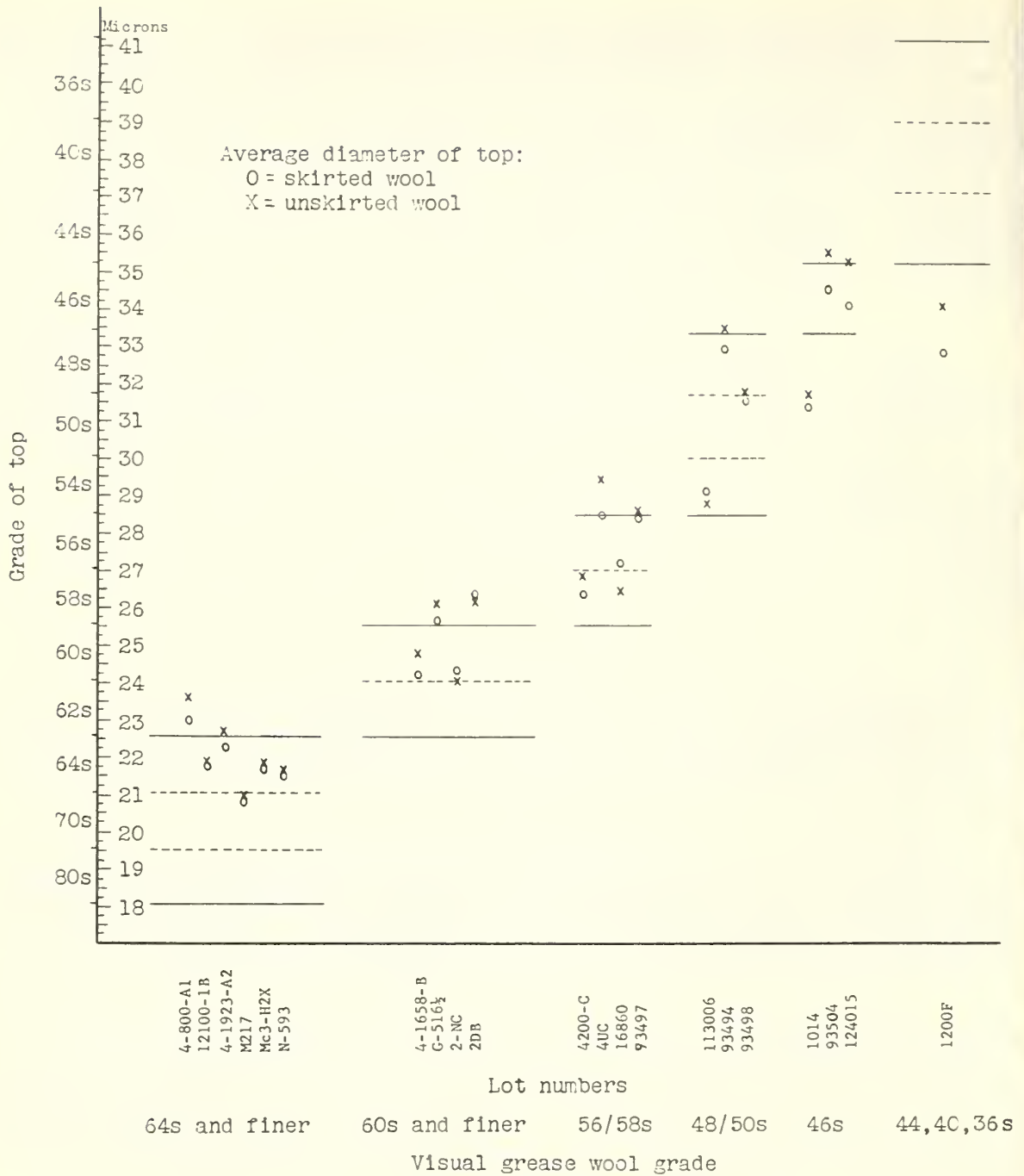


Figure 2.--Effect of skirting on grade of top, comparing average diameter of top from skirted and unskirted wool.

In view of the foregoing comparisons, statistical analyses of the testing data were made in an effort to ascertain if the fineness of the top of the skirted wool portion differed significantly from the fineness of the top of the unskirted wool portions, when analyzed by visual grade classification. The results of these analyses are shown in table 2 and are summarized as follows:

For the lots visually classified 64s and finer, the analysis of variance detected a difference in fineness between the skirted top and unskirted top that approached significance at the 5-percent probability level.

For the lots of the 60s and finer, 56/58s, and 48/50s visual grade classifications, the analysis did not detect a significant difference in fineness between the tops of the skirted and unskirted wool portions.

For the lots visually classified as 46s and 44, 40, and 36s, the analysis of variance detected differences in fineness between the tops of the skirted and unskirted wool portions that were significant at the 0.01-percent probability level.

On the basis of the data studied it would appear that the effect on the fineness or the grade of wool top by skirting was not consistent from lot to lot or from grade to grade.

Although the differences in fineness were not always statistically significant, there was a tendency for the skirted top to be slightly finer and slightly more uniform in fiber fineness than the unskirted top.

For the lots in which the fineness approached the coarse side of a grade the skirted top would frequently fall within the grade limits of a finer grade than the unskirted top.

The percentage and fineness of the wool skirted from the fleeces fails to explain satisfactorily the range in differences observed in fineness between skirted and unskirted tops.

Application of Proposed Standards for Grades of Grease Wool

The residual scoured wool of the 1-1/4-inch core samples, drawn originally from the bags of unskirted wool for clean yield determinations, was tested for fineness. The proposed standard specifications for grades of grease wool were applied to these test results to determine the grade of grease wool. Table 1 presents for comparison the testing results and grades by testing for the grease wool and the skirted and unskirted tops.

Again, to simplify the comparison between the grades of grease wool and the unskirted and unskirted tops, the "ground rules" for determining grade explained on page 5 were used. The summary on page 14 compares the grades of grease wool and skirted top by visual grade classification.

Visual grade classification	Number of lots	Number of lots in which the following occurs:		
		Grade of grease wool and skirted top identical	Grade of grease wool one numerical grade finer than skirted top	Grade of grease wool one numerical grade coarser than skirted top
64s and finer	6	4		2
60s and finer	4	2	2	
56/58s	4	2	1	1
48/50s	3	2	1	
46s	3	2		1
44, 40 and 36s	1	1		
Total	21	13	4	4

The grades of grease wool and skirted top were identical for 13 of the 21 lots. The grades of the grease wool were one numerical grade finer than the grades of the skirted top for 4 of the 21 lots, and one numerical grade coarser than the grades of the skirted top for 4 of the 21 lots.

The summary following compares the grades of grease wool and unskirted top by visual grade classification:

Visual grade classification	Number of lots	Number of lots in which the following occurs:		
		Grade of grease wool and unskirted top identical	Grade of grease wool one numerical grade finer than unskirted top	Grade of grease wool one numerical grade coarser than unskirted top
64s and finer	6	6		
60s and finer	4	2	2	
56/58s	4	2	1	1
48/50s	3	1	2	
46s	3	2	1	
44, 40 and 36s	1	1	1	
	21	13	7	1

The grade of grease wool and the grade of unskirted top were identical for 13 of the 21 lots. The grade of the grease wool was one numerical grade finer than the grade of the unskirted top for 7 of the 21 lots, and one numerical count grade coarser than the grade of the unskirted top for 1 of the 21 lots.

From the data of the preceding summaries it can be seen that grease wool grades based on sampling, testing, and applying the proposed grease wool standard specifications to the test results are identical with the grades of top produced approximately 62 times in 100. Before conclusions are drawn from these comparisons, the comparison techniques are explained further. For the grades of the grease wool and top to be regarded as identical, they had to be the same when converted to a single numerical grade; that is, a 64s grade of grease wool and a 64s grade of top were considered identical in grade. If

the grease wool grade was a 70s and the top grade was a 64s, the grease wool grade was interpreted as being one numerical grade finer than the grade of the top, and if the grease wool was a 62s grade and the top was a 64s, the grease wool grade was considered to be one numerical grade coarser.

In the foregoing comparison, it may be well to note that the differences between the grease wool grade and top grade did not exceed one numerical grade. The numerical grades, for the most part, are narrower than those in the classification employing such descriptions as "fine," "1/2 blood," and "1/4 blood" each of which embraces more than one of the numerical divisions. Thus when a lot of wool is visually appraised and described as being a fine, 64s and finer, it may be expected that by normal preparation and processing that the top produced from the wool would be no coarser than a 64s; however it could also be, by its grade description, expected to produce a 70s grade of top or one even finer. Similarly a wool designated as quarter blood has a prospective range of three numerical grades of top--54s, 50s, and 48s. It is evident that this type of visual grade classification is not as consistent or precise as the grade descriptions based on testing and the application of proposed official standards for grades of grease wool.

Attention is directed to the testing data of the skirted tops of lots 4-1923-A2, M217, G-516-1/2, 2NC, 16860, and 93504 listed in table 1. In these lots the grades of grease wool and skirted top varied by a single numerical grade. However when the average diameter figures are compared with the values marking the boundaries of the grades of the top specifications, the distinctions are less real than indicated by the differences in the grade designations. The average distance between the grade boundaries and the test's average diameters was only 0.24 microns: the distances ranged from as small as 0.09 micron to as much as 0.47 micron. These are "borderline" lots and due to the sampling, testing, and fiber variations could, on repeated testing, fall within one grade and then within another, since the average diameters are so close to the maximum or minimum average fiber diameter limits of the grades. The grades of grease wool and skirted top of lots 4200C and 93488 were not identical since their grades based on fiber distribution were not the same.

Similar comparisons can be made for the unskirted top for lots G516-1/2, 2NC, 4200C, 73497, 93494, 93498, 124015, and 1200F. In these cases the average distance between the grade boundaries and the test's average diameter was only 0.25 micron: the distances ranged from 0.03 micron to 0.66 micron.

The grade determined by testing core samples compared to visual grade of grease wool.--In order to further emphasize the application of the proposed standards for grades of grease wool the fineness data from the 1-1/4-inch core samples of 46 lots previously tested (17) were added to the data from the 21 lots of this study. The chart of figure 3 compares the average fiber diameter and grade of the core sample with the visual grease wool grade classification for 67 lots. This comparison is summarized on page 17.

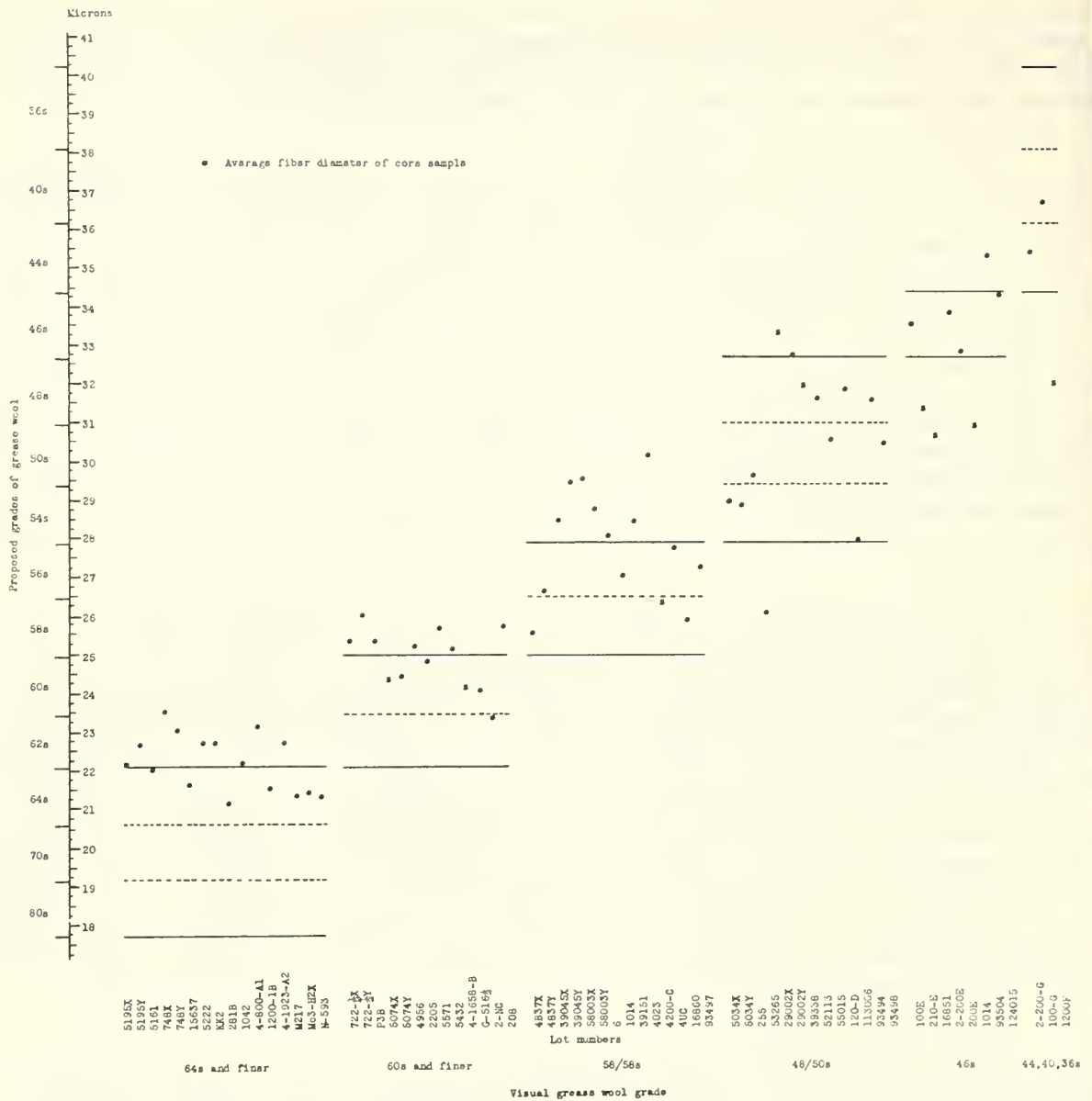


Figure 3.--Average fiber diameter and grade of the core sample compared to visual grease wool grade.

Number of lots in which the grade by test is:						
		Finer than grease		Same as		Coarser than grease
Visual grade classification	: Number of lots	: wool grade classification by:		: visual grease classification:		: wool grade classification by:
		2	1	1		2
		numerical grades	numerical grade	numerical classification:	numerical grade	numerical grades

64s and finer	16	0	0	7	8	1
60s and finer	13	0	0	6	7	0
56/58s	14	0	0	7	4	3
48/50s	13	1	0	10	2	0
46s	8	2	1	4	1	0
44, 40, and 36s	3	1	0	2	0	0
Total	67	4	1	36	22	4

The grade determined by measuring core samples and applying the proposed grease wool standard specifications was the same as the visual grade of grease wool in 53.74 percent of the tests. The grade according to test was 2 numerical grades finer than the visual grade for 5.97 percent of the tests and 1 numerical grade finer for 1.49 percent of the tests. In 32.83 percent of the tests the grade determined by test was 1 numerical grade coarser than the visual grade and 2 numerical grades coarser for 5.97 percent of the tests.

Assuming the concurrence between the grade of top produced from these 67 lots and the grade of the grease wool determined by testing the 1-1/4-inch core samples to be a measure of the application of the proposed standards for grades of grease wool it is interesting to note: the grade of grease wool determined by testing and the grade of the top of the corresponding lot were the same in 85.08 percent of the tests. The grade of the grease wool was 1 numerical grade finer for 10.44 percent of the tests and 1 numerical grade coarser for 4.48 percent of the tests. There was not a case where the difference in grades between the grease wool and top exceeded 1 numerical grade.

On the basis of the foregoing, it would appear that testing of grease wool and the use of the proposed standard specifications for grades of grease wool offered a much more consistent and precise method of describing fineness grade than did the visual grade classification methods used in this study. Not only did the testing methods determine grades on a single numerical grade basis, but by interpretation of the test results, pointed out the lots that were "borderline" cases.

LENGTH

The result of length tests on samples of grease wool staples and wool tops from the skirted and unskirted portions of the lots are presented in

table 3. The particular values in connection with length given, by lots, in this table are CCC grade classification, CCC length classification, average length, standard deviation, coefficient of variation, maximum length, minimum length, range in length, and percent stretch.

Appraisal Length Classification

For the individual lots, comparisons between the CCC length classifications made by visual appraisal, the normal and stretched grease wool staple lengths, and the fiber length of wool top determined by sampling and testing methods can be made by referring to table 3.

For the lots classified as grade 64s and finer, the testing results show that in most cases there was a reasonable division between the length classes within this grade. Also by comparing the coefficient of variation values it was noted that the graded wools of this grade classification had a more uniform staple length than that of the original bag wools.

As a point of information, coefficient of variation values observed from unpublished staple length data averaged from 14 to 21 percent for the majority of the lots of graded wools.

For the lots of the remaining grade classifications, the table shows the range in average normal staple length between the lots within each grade and length classification.

On the basis of the length data, and since the appraisals were made by methods under which no length standards or physical length measurements were specified, there was no reason to regard the appraisal length classifications as not being reasonably accurate.

Comparison of Average Normal Length of Staples, Average Stretched Length of Staples and Average Fiber Length of Skirted and Unskirted Wool Top

The data of table 3 reveal that the stretched staple length was considerably longer than either the normal staple length or the average fiber length of the skirted and unskirted top. This substantiates results of previous work reported in the publications (10), (11), and (17).

In addition to the average length data, values for standard deviation, coefficient of variation, maximum length, minimum length, and range in length can be compared by sample and lot from the data of table 3.

The range in length between the shortest and longest staples observed within a lot varies between lots within a grade and there is a noticeable tendency for this range to increase as the wools become coarser in grade and longer in length. The range in fiber length of the top follows much the same pattern as that observed for the staples.

Table 4 lists the coefficients of correlation between various physical properties and characteristics of domestic wool. By referring to this table it will be noted that there is a high relation between average diameter of grease wool and average normal length of grease wool staple ($r = .76$). There is also a high relation between average diameter of grease wool and average stretched length of grease wool staples ($r = .87$). The difference between these two values of the coefficients of correlation is not statistically significant.

The relation between the average normal length of grease wool staples and the average stretched length of grease wool staples is very high ($r = .99$).

The relationships between the average normal length of grease wool staples and the average fiber length of top of the skirted and the unskirted portions are high ($r = .87$, $r = .86$). The values of the coefficients of correlation between the average stretched length of grease wool and the top lengths are identical to the above ($r = .87$, $r = .86$).

The Effect on Length of Top by Skirting

Length testing data such as average fiber length, standard deviation, coefficient of variation, maximum and minimum fiber length, and range in fiber lengths for the skirted and unskirted top samples are given by lot in table 3.

Referring to the data of this table it will be seen that in 9 of the 21 lots the average fiber length of the skirted top was slightly longer than the average fiber length of the unskirted top. In 11 of the 21 lots the average fiber length of the skirted top was slightly shorter than the unskirted top. It was the same for 1 of the 21 lots. The differences averaged approximately 0.09 inch and ranged from no difference to 0.21 inch.

There was no definite trend observed in the variability in fiber lengths of the skirted and unskirted tops as revealed by the length coefficient of variation or the range in fiber lengths.

As previously noted, the coefficient of correlation values between fiber lengths of the skirted and unskirted tops and the normal and stretched staple lengths are very similar ($r = .87$, $r = .86$).

On the basis of the foregoing data, it is observed that the removal of skirts from fleeces does not appear to influence the length of top.

Testing Staples for Determining Length of Grease Wool

The data of this report indicate that estimates of the average staple length and range of staple lengths within a graded lot can be made by using the testing procedures employed in this study.

The accuracy and consistency of testing methods for length were covered by the work reported on testing of 46 lots of wool (11) and (17). This work served as the background for the publication (11) presenting staple length sampling schedules for raw wool packaged in bags.

The testing methods used in this report offer a more objective means of describing length than the methods employed by visual inspection. They can provide not only accurate estimates of average staple length but also the range in length of staples within the lot.

Percent Stretch of Grease Wool Staples

The values for percent stretch of grease wool staples are given by lot in table 3.

The average percent stretch, by lot, for the wools of the grade 64s and finer ranged from 27.58 percent to 38.52 percent. For the wools of the grade 60s and finer the range in percent stretch was from 25.67 percent to 32.64 percent. A range in percent stretch of from 23.94 percent to 36.55 percent was observed in the wools of the grade 56/58s. The percent stretch for the 48/50s wools ranged from 23.94 percent to 39.74 percent. For the 46s wools the percent stretch ranged from 22.50 percent to 28.85 percent. The percent stretch of the one lot of the grade 44, 40 and 36s was 23.09 percent.

On the basis of the data studied, percent stretch appears to be more closely associated with the length of the grease wool than with its grade.

There is a substantial and significant inverse relationship between average normal length of grease wool staples and percent stretch of grease wool staples ($r = -.56$). However there is a low inverse correlation between average stretched length of grease wool staples and percent stretch of grease wool staples; the correlation coefficient ($r = -.42$) is not significant. Also the correlation between the average diameter of grease wool and percent stretch of grease wool staples is inverse and low; the coefficient of correlation ($r = -.33$) is not significant at the 5-percent probability level.

STAPLE CRIMP

The staple crimp test data for samples of grease wool staples are shown in table 5. Included in this table, listed by lot and by CCC grade classification, are average number of crimps per inch, measured fineness of grease wool, percentages of three different crimp types, and crimp type index.

Crimps Per Inch

Crimp-per-inch data appear to group into divisions according to visual grade classifications, with very slight overlapping in average number of crimps per inch between grades. The tabulation on page 21 shows the average, minimum, and maximum mean number of crimps per inch for the lots tested within each of the visual grade classifications:

Visual grade classification	Number of lots	Average number of crimps per inch	Minimum number of crimps per inch	Maximum number of crimps per inch
64s and finer	6	15.2	14.5	16.0
60s and finer	4	11.6	9.8	12.8
56/58s	4	9.0	8.0	9.6
48/50s	3	6.4	6.2	6.6
46s	3	4.2	3.9	4.6
44, 40 and 36s	1	4.2	-	-

The studies on crimp confirm the general observation that crimpiness decreases as grade becomes coarser. In these studies a grade-to-grade decrease of from 2 to 4 crimps in the average number per inch was found as the grades dropped from fine to coarse.

Individual lot comparisons between the average number of crimps per inch and the measured fineness of grease wool show that as the average diameter of the grease wool becomes greater the average number of crimps per inch becomes fewer. Additional comparisons between crimp-per-inch data and length of staples denote that as the grease wool staples become longer the average number of crimps decreases. There did not appear to be too much of a relation between the average number of crimps per inch and the percent stretch of the grease wool staples. Coefficient of correlation values indicated that the number of crimps per inch is more highly related to fineness than to length.

There is a high inverse relation between the average diameter of grease wool and the average number of crimps per inch ($r = -.95$). The correlations between the average normal and the average stretched length of grease wool staples and the average number of crimps per inch are also inverse and high ($r = -.82$, $r = -.83$). The correlation between percent stretch of grease wool staples and the average number of crimps per inch is low ($r = .40$) and not significant at the 5-percent probability level.

Crimp Types

The percentages of the different types of crimp estimated within each of the 21 lots are listed in table 5. Also shown are the crimp type indices.

The procedure for determining the crimp type index is covered under Materials and Methods. In application, crimp type index is a numerical value used to indicate or measure the distinctness and prominence of crimp boldness within a lot. For example a high crimp index indicates that there is a large percentage of the "bold" type crimp wools (crimp with a conspicuous waviness with a pronounced depth of wave) and "intermediate" type crimp wools (crimp well defined but not exhibiting as deep a waviness as the bold type) within a lot. The lower the crimp index the larger the percentages of "intermediate" and "dim" type crimp wools (crimp of the dim type are only dimly visible) within a lot. The highest crimp index attainable is 300, and the lowest index is 100.

Data of this study disclosed that as the wools became coarser in fiber diameter and longer in staple length there was a tendency for the crimp type index to become higher. However as the number of crimps per inch increased, the crimp type index appeared to become lower. Changes in the percent stretch of grease wool staples did not seem to have much effect on the crimp type index.

On the basis of the coefficient of correlation values given in table 4, crimp type index appears to be more closely associated with length than with fineness or crimp-per-inch.

There is a marked relationship between average normal length of grease wool staples and crimp type index ($r = .70$), and the relationship ($r = .71$) between average stretched length of grease wool staples and crimp type index is also marked.

The relationship between average diameter of grease wool and crimp type index is substantial ($r = .59$).

There is a substantial inverse relationship between the average number of crimps per inch and crimp type index ($r = -.56$).

The correlation between percent stretch of grease wool staples and crimp type index is inverse and low ($r = -.26$), and not significant at the 5-percent probability level.

YIELD

The clean wool yields at various stages of processing and yields determined by core sampling the lots in the grease state are tabulated in table 6. The term yield as used herein refers to the amount of clean wool fiber present

Mill Yields

Scoured yields.--Scoured yield was determined by weighing and analyzing the wool after scouring. Each lot of scoured wool was weighed 48 hours after scouring to allow the wools to come to moisture equilibrium.

The average yields presented in table 6 for the 21 lots indicate that it is very difficult to sample large lots of scoured wool for moisture content. The average scoured yield for all lots is 51.66 percent, approximately 3.0 percent higher than the average top-noil-waste (T-N-W) yield and about the same percent higher than the card sliver yield.

The carding and combing operations definitely put the wools in a very homogeneous condition so that sampling can be efficiently accomplished. It is quite a problem to represent adequately by sampling, a bin of 3 or 4 thousand pounds of scoured wool when very little moisture homogeneity exists.

The high yielding tendency of the scoured lots makes it obvious that in the bottom and middle of the bins there were portions heavily laden with moisture that were not properly represented on a percentage basis. For this reason it is felt that core sampling yields should be compared either to card sliver or T-N-W yields for proper evaluation.

Core sampling scoured wools for moisture determination.--During the mill processing two lots of scoured wool (93504 and 1014) were baled and sampled with the 1-1/4-inch coring tube to observe moisture differences both within and between bales. In Lot No. 1014, 80 individual 1-1/4-inch cores were drawn from 8 bales. These cores ranged in moisture percent from 4.18 to 28.77, while the widest difference in bale average was from 7.52 to 16.53 percent. Lot No. 93504 produced 6 bales of scoured wool, and the 60 cores which were drawn from these bales had a range of 3.93 percent to 10.98 percent. The widest spread in average moisture percent between bales was 4.73 percent to 8.31 percent.

Even though Lot No. 93504 had the most uniform moisture content, the problem of sampling scoured wool for moisture content is evident. Scoured wools coming from a dryer do not seem to have the moisture uniformity necessary to pursue an economical sampling schedule.

Card sliver and T-N-W yields.--In the calculation of card sliver and T-N-W yields both sets of figures include the standard wool (wool with 14% non-wool components) present in the wastes. The card sliver yields include the standard wool in the card sliver, card waste, No. 1 burr waste, and No. 2 burr waste. The T-N-W yields include the standard wool in the top, noil, card waste, No. 1 burr waste, No. 2 burr waste, and French burry waste (if combed on French combs).

The following tabulation shows the difference in percent of the average T-N-W yields from the average card sliver yields by grade:

Visual grade classification	Number of lots	Average card sliver yield	Average T-N-W yield	Difference
64s and finer	6	41.14	40.50	-0.64
60s and finer	4	43.49	43.08	-0.41
56/58s	4	49.50	49.10	-0.40
48/50s	3	53.02	53.28	+0.26
46s	3	59.07	58.76	-0.21
44, 40 and 36s	1	65.94	66.49	+0.55

The plus values indicate possible errors in the weighing of mill products; however, from a yield standpoint they are not serious. On the average for all lots the T-N-W yield is 0.32 percent lower than the card sliver yield. This small loss is to be expected as there is some invisible loss of fiber or "fly" during processing operations.

The impurities carried by grease wool are the most important single factor influencing yield; however, by comparing top-noil-waste yields to the various physical properties and characteristics of the wool, it will be noted that the higher yields are obtained from the coarser and longer wools. That is, as the wool increases in fiber diameter and length of staple, there is also a definite tendency for the T-N-W yield to increase.

Staple crimp is tied in with yield too. The wools with a higher number of crimps per inch usually yield less than those with a lesser number of crimps per inch. Crimp type index is not as closely associated with yield as the number of crimps per inch; however it is related to some extent in that those wools in this study with high crimp type indices ordinarily had the higher yields.

The percent stretch of the grease wool staples appears to have little value as an indicator of yield.

The average diameter of grease wool, the average normal length of grease wool staples, and the average stretched length of grease wool staples are highly related to top-noil-waste yield ($r = .90$, $r = .85$, and $r = .87$).

There is a high inverse relationship between average number of crimps per inch and top-noil-waste yield ($r = -.84$). The relation between crimp type index and top-noil-waste yield is substantial ($r = .51$).

There is a low inverse correlation between percent stretch of grease wool staples and top-noil-waste yield ($r = -.37$); this value is not significant at the 5-percent probability level.

Coring Yields

In table 6 the column headed "Original 1-1/4-inch" under core yields is a tabulation of clean yields determined by core testing the lots at the time of acceptance of the wools by the Commodity Credit Corporation into the loan program. The column headed "1-1/4-inch" tabulates the coring yields determined during this study just prior to mill processing. The averages for the two core yields show that the tests made just prior to processing yielded approximately 0.8 percent heavier than the tests made when the wools went into the loan program. Part of this difference can be attributed to drying out during storage; however, it is quite small and points out the consistency of core testing. This consistent pattern is further accentuated by the fact that the core tests on the lots when they went into the loan program were made by commercial testing companies and the tests made prior to processing were performed by the USDA Wool Laboratory. Examination of the data shows that 1-1/4-inch coring yields are not biased for any grade of wool.

Comparisons between yields based on the 1-1/4-inch core samples and the various physical properties and characteristics of the wool are almost identical to those observed between T-N-W yields and the various properties.

The values of the coefficients of correlation indicate that fineness, length, and number of crimps per inch are associated with yield in a higher degree than crimp type index and percent stretch of grease wool staples.

There is a very high relation between top-noil-waste yield and the yield based on the 1-1/4-inch core sample ($r = .99$).

The average diameter of grease wool, the average normal length of grease wool staples, and the average stretched length of grease wool staples are highly related to yields based on 1-1/4-inch core sample ($r = .91$, $r = .86$, and $r = .86$).

The relationship between the average number of crimps per inch and yields based on the 1-1/4-inch core sample is inverse and high ($r = -.86$). The relation between crimp type index and yields based on the 1-1/4-inch core sample is substantial ($r = .52$).

The low inverse correlation ($r = -.42$) between percent stretch of grease wool staples and yield based on 1-1/4-inch core sample is not significant at the 5-percent probability level.

Carding and Combing Wastes

The data of table 7 make it easy to compare the clean standard wool (wool with 14 percent non-wool components) found, by analysis, in the processing wastes to the amount of grease wool that went into processing. These results strongly indicate that the amount of clean standard wool present in the total wastes (except noil) will be approximately 2.25 percent of the grease and the clean standard wool in the carding wastes will be 1.75 percent of the grease weight.

The 21 lots ranged in percent noil on top and noil from 7.3 percent to 14.9 percent (or a spread in "noilage" of 7.6 percent), but the percent standard clean wool in the carding wastes and total wastes (except noil) remained approximately the same. This situation suggests that the clean wool appearing in the wastes is primarily controlled by the carding and combing machinery rather than by the characteristics of the wool being processed.

Lot 4-1658-B had the largest amount of wool in the carding wastes, 2.4 percent, and also had the highest percent of vegetable matter in the grease state; however, Lot N-593 had 1.5 percent clean wool in the carding wastes but only 0.50 percent vegetable matter in the grease wool. Vegetable material has some effect on the amount of clean wool in the carding wastes, but in this study it was not conspicuous.

On the basis of these figures and other unpublished processing data it would appear that a lot of wool being processed into top will lose approximately 2.0 percent of its grease weight as clean wool in the wastes irrespective of noilage or vegetable matter content. There were no heavy burry lots in this group; however, such wools may present a different story.

Vegetable Matter

Test data relating vegetable matter found in the grease wool to vegetable matter present in card sliver and top are found in table 8.

Vegetable matter from a weight standpoint is mostly removed during the carding operations; however, small amounts stay with the wool and become a subsequent factor affecting the value of the top.

The table presents the vegetable matter in the grease wool and card sliver as a percent of the weight, but the vegetable matter in the top is expressed as pieces per ounce of top. Even though these pieces are of no consequence by weight, their presence can greatly affect top value.

It can be seen from the data that the vegetable matter in every case was reduced below 1.0 percent by weight in the carding operation, but there were wide differences in the number of pieces found per ounce of resultant top.

Lot 121001B had 67 pieces of vegetable matter in one ounce of top, the most for any one lot, but the percent vegetable matter left in the card sliver was low (0.21%). Lot 4-200-C had 0.60 percent vegetable matter in the card sliver stage, but only 23 pieces per ounce of top. Lot 4-1658-B, with 5.30 percent vegetable matter in the grease state had only 25 pieces per ounce of top. Lots 93497 and 93498 had 1.90 percent vegetable matter in the grease wool, very small percentages in the card sliver, but fairly high amounts in the top.

Determination of the types of vegetable matter that carry through into top would be of considerable value so that possible control measures could be instituted from a wool production standpoint. The chart of figure 4 shows the types of vegetable matter found in the grease wool and their relationship to the number of pieces present per ounce of top.

It can be seen on the chart that the kinds of burrs contained in the lots processed are not the principal contributors to top contamination.

Top Yield and Noilage

The yield or percentage of top and noilage resulting from the skirted and unskirted portions of the lots are given in table 9. Individual lot comparisons can be made by referring to this table.

Top yield.--It will be noted that the average top yield of the 21 lots is 41.03 percent for the skirted portions and 40.71 percent for the unskirted portions. This is less than the average yield of 48.30 percent for the T-N-W and less than the average yield based on the 1-1/4-inch core samples of 49.49 percent. Of course this difference in yield is due to the combing out of the noils and the removal of waste products.

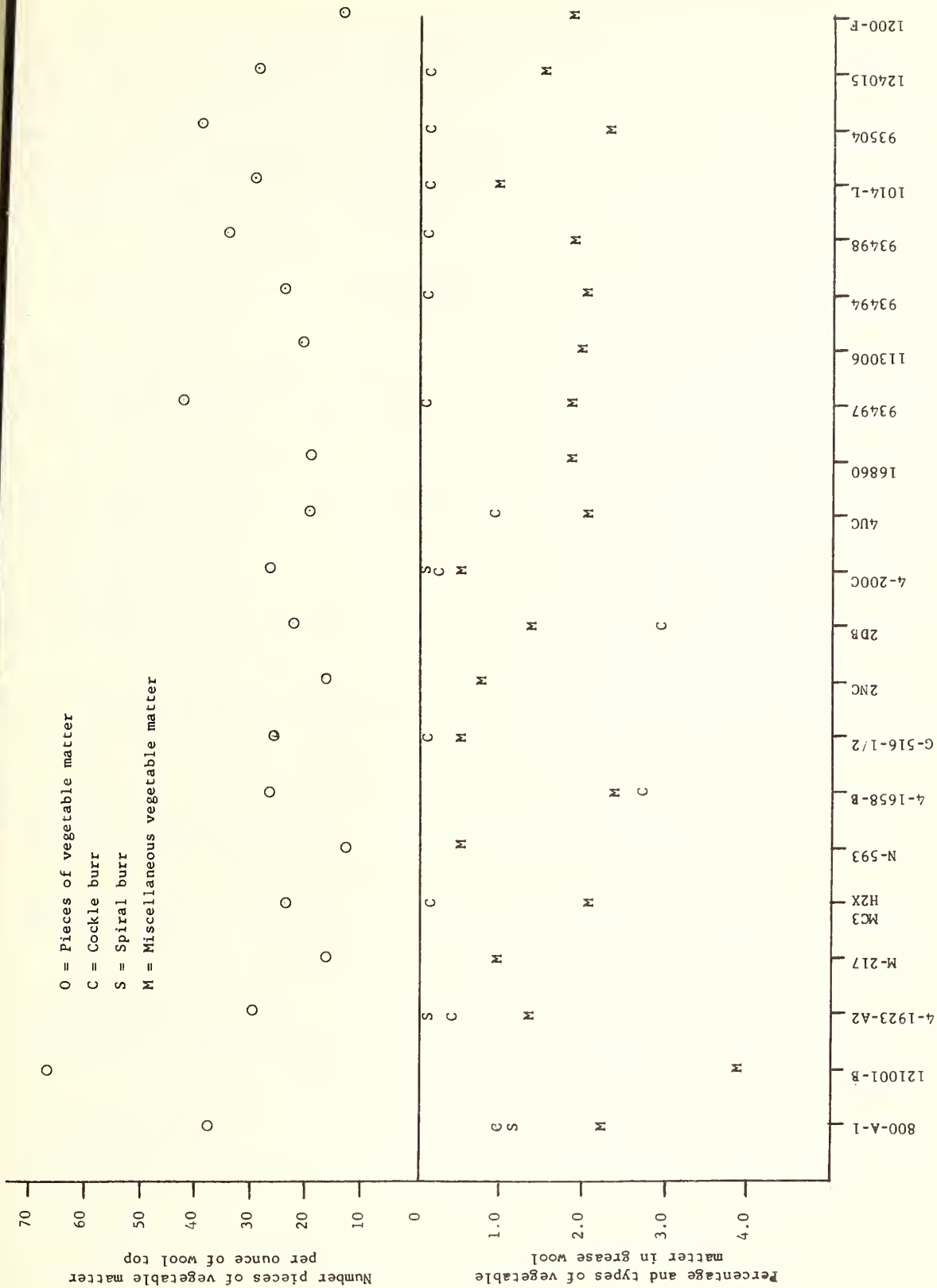


Figure 4.--Percentage and types of vegetable matter in grease wool compared to number of pieces of vegetable matter per ounce of wool top.

The coefficient of correlation values of table 4 indicate that top yield from both the skirted and unskirted portions are associated with fineness, length, and staple crimp to a slightly higher degree than either the T-N-W yield or the yield based on the 1-1/4-inch core sample. However, all yields follow the same order. That is, as the wools become coarser and longer and the crimp type index becomes greater, the yields are inclined to become greater. This situation is reversed in crimps-per-inch data. As the number of crimps per inch increased, the yield decreased or as the number of crimps per inch became less frequent, the yield tended to increase.

There is a high relation between average diameter of grease wool and the top yield of the skirted and unskirted portions ($r = .92$ and $r = .93$).

The average normal length of the grease wool staples and the skirted and unskirted top yields are highly related ($r = .88$ and $r = .89$). A similar comparison with the stretched length of grease wool staples gives coefficient of correlation values of $r = .90$ and $r = .90$.

The inverse relationships ($r = -.86$ and $r = -.87$) between the average number of crimps per inch and the yields of the skirted and unskirted tops are high.

The correlations between crimp type index and the top yields of the skirted and unskirted portions are $r = .57$ and $r = .59$; these values are significant at the 1-percent probability level.

There are low inverse correlations between the percent stretch of the grease wool staples and the top yields ($r = -.37$ and $r = -.41$) that are not significant at the 5-percent probability level.

The correlations between the top-noil-waste yields, the yields based on the 1-1/4-inch core samples, and the yields of top from the skirted and unskirted portions are all very high with values to the order of $r = .99$.

Noilage.--Noilage or the percent noil on top and noil is a percentage value representing the relationship between the weight of noils combed out of a given lot and the sum of the weights of the tops and the noils.

The data of this study indicate that for the most part lower noilage values occur in the coarser and longer wools with fewer crimps per inch and with higher crimp type indices than among the finer and shorter wools with more crimps per inch and with lower crimp type indices.

Coefficient of correlation values indicate that the crimp type index, fineness, and length are more closely associated with the percent noilage of the skirted and unskirted portions than the other physical properties tested.

The correlations between crimp type index and the percent noilage of the skirted and unskirted portions are high and inverse ($r = -.74$ and $r = -.73$).

There is a high inverse relation between average diameter of grease wool and the percent noilage of the skirted and unskirted portions ($r = -.72$ and $r = -.70$).

The inverse relationships between the average normal length of the grease wool staples and the percent noilage of the skirted and unskirted portions are high ($r = -.71$ and $r = -.69$). The relationships between the average stretched length of the grease wool staples and the percent noilage of the skirted and unskirted portions are also inverse and highly related ($r = -.72$ and $r = -.70$).

There are marked relationships between the number of crimps per inch and the percent noilage of the skirted and unskirted portions ($r = .65$ and $r = .59$).

The relationships between the percent stretch of the grease wool staples and the percent noilage of the skirted and unskirted portions are low ($r = .26$ and $r = .30$); these values are not significant at the 5-percent probability level.

There are marked inverse relationships between the various yield data and the percent noilage of the skirted and unskirted portions. The coefficient of correlation values indicate that top yields are more closely related to the noilage values than the yields of the T-N-W or those based on the 1-1/4-inch core sample. These specific values may be noted by referring to table 4.

The Effect on Top Yield and Noilage by Skirting

Comparisons between the percent top yields of the skirted and unskirted portions and between the percent noilages of these portions can be made by referring to table 9.

The average yield of top obtained in the processing of the grease wool of the skirted portions of the lots was 41.03 percent. This value is slightly higher than the 40.71 percent obtained from the unskirted portions.

The average percent noilage of the skirted portions is 11.41 percent and for the unskirted portions 11.60 percent. This difference is very small.

According to the coefficient of correlation values of table 4 there is a very high relationship ($r = .99$) between the top yield of the skirted portion and the top yield of the unskirted portion, and the percent noilages of the skirted and unskirted portions are also very highly related ($r = .96$).

The coefficient of correlation values between the top yield and the various other physical properties and the noilage and other physical properties show very little difference between the skirted and unskirted portions.

The data of this study do not indicate that skirting influences either top yield or percent noilage.

COLOR

Color as used in this study refers to the discoloration in wool that cannot be removed in the normal scouring operations. Scoured wool is usually more of a light ivory or a cream color than a true white; a yellow cast is the most objectionable and prevalent color in the majority of wools.

Spectrophotometric measurements of color changes in wool during processing were reported in 1951 (18). In this study, color changes in various representative processes were traced and it was found that the spectrophotometer did measure changes in color occurring during processing.

A report covering an economic evaluation of color in domestic wool, the physical measurements of wool top color determined by an automatic color difference meter, and the development of a color comparator for wool was published in 1957 (15).

The techniques used for determining color in the current study are covered under the materials and methods section on page 6.

The results of color testing on samples of scoured 1-1/4-inch cores, scoured britch wool, scoured stained wool, and skirted and unskirted portions of mill scoured wool, card sliver and top are given in table 10.

Ratings for color were made by using the wool color comparator and are listed by CCC grade classification and lot. The whitest color is designated as A, the next whitest as B, C, D, and E in that order. E minus was used when the color was deeper than the example E.

Wool Top Color

The color ratings for the top of the 21 lots of this study are listed in table 10. It will be noted that top produced from the lots of the finer grades had a definite tendency to be whiter than the top produced from the coarser grades.

The correlation data of table 4 indicate that as the average diameter of the grease wool became greater and the staple length became longer, there was a marked tendency for the color rating to be lower. There were also indications that the higher yielding wools of this study, which were the medium and coarser grades, were more closely associated with lower color ratings than the lower yielding wools.

There were further indications that higher color ratings occurred as those lots with the greater number of crimps per inch. Also the lots that had a higher percent noilage tended to have higher color ratings. These were, of course, the finer grades of wool.

There was a very slight association between crimp type index, percent stretch of grease wool staples, and color ratings on top.

Specific coefficients of correlation between the color ratings of the top and the various physical properties measured are listed in table 4.

Color Ratings of Scoured Samples
Representative of Various Stages of Processing

Comparisons of the color ratings of the different samples and of the individual lots can be made by referring to table 10.

On the basis of the data, it appears that the color ratings obtained on the scoured core samples are reliable indicators of the color ratings that can be expected from the lot in the scoured wool, card sliver, and top stages.

There was a high relation between the color rating of the scoured core sample and the britch wool, the unskirted portions of the mill scoured wool, the card sliver and the top. The coefficient of correlation values were .89, .90, and .93, respectively.

The relationship between the color ratings of the skirted portion of the mill scoured wool and the color ratings of the unskirted portion of the scoured wool was high ($r = .80$).

There were high correlations between the color ratings of the skirted portions of the mill scoured wool and the color ratings of the skirted portions of the card sliver and top ($r = .87$, $r = .89$).

The correlations between the color ratings of the unskirted portion of the mill scoured wool and the color ratings of the unskirted portion of the card sliver and top were high ($r = .89$, $r = .93$).

There was a very high relationship between the color ratings of the skirted and unskirted portions of the card sliver ($r = .97$).

The correlation between the color ratings of the skirted and unskirted portions of the card sliver and the color ratings of the skirted and unskirted portions of the top were high ($r = .93$, $r = .97$).

The relationship between the color ratings of the skirted and unskirted top was high ($r = .94$).

The Effect on Color of Wool by Skirting

Comparisons between the color ratings of skirted and unskirted portions in mill scoured wool, card sliver, and top can be made by referring to table 10.

It will be noted that the color ratings for the scoured britch wool samples are the same as for the scoured core sample for 12 of 19 lots. For 6 of the 19 lots the color ratings of the britch wool are lower than the ratings of the scoured core sample; the britch wool has a higher color rating for 1 of the 19 lots. No britch wool sort was made from 2 of the 21 lots.

In all cases the color ratings of the scoured stained wools are lower than the color ratings of the scoured core sample, and in most instances the color rating of the scoured stained wool was E- or of a darker color than the lowest comparator example.

The skirting of the britch and stained wool from the fleeces apparently had little influence on the color ratings of the scoured wool in the various processing stages. Statistical analyses of the color test data of this study failed to detect significant differences at the 5-percent probability level between the color ratings of the skirted and unskirted portions of the mill scoured, card sliver, and top samples.

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APPENDIX

Table 1.--Fineness: C.C.C. grade classification, grade by test, average fiber diameter, standard deviation, coefficient of variation, fiber distribution and percentage of britch and stained wools skirted from fleeces for 21 lots

C.C.C. grade classifi- cation	Lot number	Wool sample	:britch and : :stain removed: by : :from fleeces :test :	:Percentage of: :britch and : :stain removed: by : :from fleeces :test :	:Grade : :fiber : :diameter: deviation: variation:	:Average : :microns : :microns :	:Coefficient of: :variation: variation:	Fiber distribution											
								:Minimum, :microns :	:Maximum, :microns :	:Percent Percent									

1/ See footnotes at end of table.

Continued--

Table 1.--Fineness: C.C.C. grade classification, grade by test, average fiber diameter, standard deviation, coefficient of variation, fiber distribution and percentage of britch and stained wools skirted from fleeces for 21 lots--continued

C.C.C. grade classification	Lot number	Wool sample	Percentage of: britch and stain removed: from fleeces	Grade by test	Average fiber diameter: deviation: variation	Microns	Coefficient of variation	Fiber distribution					
								Minimum, microns		Maximum, microns		Percent	Percent
								10-30.0	30.0-40.0	40.0-50.0	50.0-60.0	Percent	Percent
1/2 blood, 60s and finer	4-1658-B	1-1/4-inch cores	-	60s	24.05	4.97	20.67	87.61	-	12.39	0.50	-	-
		Britch	1.52	56s	26.82	6.51	24.27	72.13	-	27.87	-	0.24	-
		Stained	0.12	58s	25.13	6.13	24.39	81.63	-	18.37	-	0.24	-
		Top, skirted - Fr.	-	60/62s	24.23	5.05	20.84	88.26	-	11.74	0.36	-	-
		Top, unskirted - Fr.	-	60s	24.75	5.48	22.14	85.01	-	14.99	1.00	-	-
Do.	G-516-1/2	1-1/4-inch cores	-	60s	23.98	6.00	25.02	85.63	-	14.37	1.12	-	-
		Britch	2.31	58/56s	26.40	7.80	29.54	73.49	-	26.51	-	1.00	-
		Stained	0.55	54/48s	28.27	8.88	31.41	-	89.50	-	10.50	-	0.40
		Top, skirted - N. 3/	-	58s	25.63	6.43	25.09	80.00	-	20.00	-	0.49	-
		Top, unskirted - N.	-	58s	26.10	6.65	25.48	78.13	-	21.87	-	-	0.62
Do.	2-NC	1-1/4-inch cores	-	62s	23.30	5.00	21.46	90.37	-	9.63	0.49	-	-
		Britch	0.19	56/54s	27.04	8.35	30.88	72.25	-	27.75	1.85	-	-
		Stained	1.46	58s	25.42	6.83	26.87	78.88	-	21.12	-	0.49	-
		Top, skirted - Fr.	-	60s	24.30	5.58	22.96	87.76	-	12.24	1.48	-	-
		Top, unskirted - Fr.	-	60/62s	24.18	5.40	22.33	87.62	-	12.38	1.00	-	-
Do.	2DB	1-1/4-inch cores	-	58s	25.65	6.38	24.87	76.89	-	23.11	-	0.12	-
		Britch	2.69	54/56s	28.03	6.83	24.37	66.01	-	33.99	-	0.50	-
		Stained	0.09	58/54s	26.00	7.59	29.19	75.01	-	24.99	-	1.12	-
		Top, skirted - N.	-	58s	26.35	6.29	23.87	76.50	-	23.50	-	0.24	-
		Top, unskirted - N.	-	58s	26.22	6.28	23.95	77.30	-	22.70	-	0.30	-
3/8 blood, 56/58s	4200-C	1-1/4-inch cores	-	58/56s	26.30	6.91	26.27	73.60	-	26.40	-	0.10	-
		Britch	1.50	48s	31.74	8.94	28.17	-	81.40	-	18.60	-	0.50
		Stained	0.89	50s	29.81	8.45	28.35	55.60	-	44.40	-	1.90	-
		Top, skirted - N.	-	58s	26.38	6.30	23.88	74.70	-	25.30	-	0.30	-
		Top, unskirted - N.	-	58s	26.93	6.65	24.69	73.90	-	26.10	-	0.70	-
Do.	4UC	1-1/4-inch cores	-	56/54s	27.69	7.38	26.65	63.30	-	36.70	-	0.60	-
		Britch	0.19	48/46s	31.00	9.62	31.03	-	84.20	-	15.80	-	1.10
		Stained	0.59	50/48s	29.85	8.20	27.47	-	89.30	-	10.70	-	0.40
		Top, skirted - N.	-	56/54s	28.53	7.12	24.96	60.50	-	39.50	-	0.80	-
		Top, unskirted - N.	-	54s	29.45	7.15	24.28	57.00	-	43.00	-	1.10	-

See footnotes at end of table.

Continued--

Table 1.--Fineness: C.C.C. grade classification, grade by test, average fiber diameter, standard deviation, coefficient of variation, fiber distribution and percentage of britch and stained wools skirted from fleeces for 21 lots--continued

C.C.C. grade classification	Lot number	Wool sample	:Percentage of: : britch and : : stain removed: by : :from fleeces :test :	:Grade :Average : : fiber :Standard : : diameter:deviation:variation:	: Microns	: Microns	: Coeffi- : cient of: : variation:	: Fiber distribution					
								Minimum, : microns	Maximum, : microns	Percent	Percent	Percent	Percent
3/8 blood, 56/58s	:16860	1-1/4-inch cores	-	58s	25.83	6.32	24.47	76.80	-	23.20	-	0.30	-
		Britch	0.20	54s	28.68	8.70	30.33	61.50	-	38.50	-	1.20	-
		Stained	0.13	54/48s	28.66	9.04	31.54	-	89.20	-	10.80	-	0.50
		Top, skirted - N.	-	56s	27.20	6.78	24.93	70.10	-	29.90	-	0.40	-
		Top, unskirted - N.	-	58s	26.50	6.18	23.32	75.50	-	24.50	-	0.20	-
Do.	:93497	1-1/4-inch cores	-	56s	27.23	6.88	25.27	71.20	-	28.80	-	0.50	-
		Britch	0.26	46/40s	33.70	11.95	35.46	-	71.30	-	28.70	-	2.80
		Stained	5.32	54s	29.28	7.83	26.74	59.79	-	40.21	-	1.20	-
		Top, skirted - N.	-	56s	28.50	7.22	25.33	64.00	-	36.00	-	1.00	-
		Top, unskirted - N.	-	54s	28.57	7.40	25.90	64.30	-	35.70	-	1.30	-
1/4 blood, 48/50s	:113006	1-1/4-inch cores	-	54s	27.90	7.20	25.81	65.50	-	34.50	-	0.50	-
		Britch	0.30	46s	32.98	10.03	30.41	-	76.70	-	23.30	-	0.70
		Stained	1.23	50/48s	30.39	9.18	30.21	-	84.90	-	15.10	-	0.60
		Top, skirted - N.	-	54s	29.13	7.55	25.92	59.10	-	40.90	-	1.20	-
		Top, unskirted - N.	-	54s	28.85	7.40	25.65	61.40	-	38.60	-	0.70	-
Do.	:93494	1-1/4-inch cores	-	48s	31.50	8.54	27.11	-	85.40	-	14.60	-	0.40
		Britch	1.08	40/36s	36.45	12.33	33.83	-	62.80	-	37.20	-	3.40
		Stained	3.79	46/40s	34.33	10.93	31.84	-	74.10	-	25.90	-	2.40
		Top, skirted - N.	-	48s	33.00	8.60	26.06	-	80.00	-	20.00	-	0.60
		Top, unskirted - N.	-	46/48s	33.57	8.68	25.86	-	78.00	-	22.00	-	0.30
Do.	:93498	1-1/4-inch cores	-	50s	30.42	8.49	27.91	52.90	-	47.10	-	1.50	-
		Britch	0.74	4/36/36s	40.18	14.65	36.46	-	55.90	-	44.10	-	8.30
		Stained	4.59	46/44s	34.21	8.93	26.10	-	77.70	-	22.30	-	1.60
		Top, skirted - N.	-	50/48s	31.53	8.00	25.37	-	84.70	-	15.30	-	0.10
		Top, unskirted - N.	-	48/50s	31.80	8.35	26.26	45.80	-	54.20	-	1.90	-
Low 1/4 blood 46's	:1014	1-1/4-inch cores	-	50/48s	30.85	8.65	28.04	-	85.80	-	14.20	-	0.50
		Britch	1.10	44/36s	35.68	11.91	33.38	-	67.90	-	32.10	-	3.50
		Stained	1.80	40s	36.53	10.73	29.37	-	65.30	-	34.70	-	2.50
		Top, skirted - N.	-	50/48s	31.43	8.88	28.25	-	84.00	-	16.00	-	0.30
		Top, unskirted - N.	-	48s	31.78	8.52	26.81	-	83.80	-	16.20	-	0.30

See footnotes at end of table.

Continued--

Table 1.--Fineness: C.C.C. grade classification, grade by test, average fiber diameter, standard deviation, coefficient of variation, fiber distribution and percentage of britch and stained wools skirted from fleeces for 21 lots--continued

C.C.C. grade classification	Lot number	Wool sample 1/	Percentage of: : britch and : : stain removed: by : : from fleeces : test :	Grade : : fiber : : diameter: deviation:	Average : : fiber : : diameter: deviation:	Coefficient of variation:	Fiber distribution											
							Minimum, : : microns :	Maximum, : : microns :	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Low 1/4 blood, 46s	: 93504	1-1/4-inch cores	-	44s	35.34	10.03	69.40	30.60	-	30.60	-	1.40						
	:	Britch	2.06	36s	38.06	11.44	59.50	40.50	-	40.50	-	3.20						
	:	Stained	2.83	36/36s-	38.39	12.68	61.10	38.90	-	38.90	-	5.70						
	:	Top, skirted - N.	-	46/48s	34.68	8.73	76.50	23.50	-	23.50	-	0.70						
	:	Top, unskirted - N.	-	44s	35.53	9.45	71.50	28.50	-	28.50	-	1.60						
Do.	: 124015	1-1/4-inch cores	-	46s	34.25	8.72	76.10	23.90	-	23.90	-	1.00						
	:	Britch	2.84	40s	37.93	9.98	60.80	39.20	-	39.20	-	2.70						
	:	Stained	2.50	46/40s	33.73	10.48	74.90	25.10	-	25.10	-	2.10						
	:	Top, skirted - N.	-	46/48s	34.13	8.55	76.40	23.60	-	23.60	-	0.20						
	:	Top, unskirted - N.	-	44/46s	35.32	8.90	73.00	27.00	-	27.00	-	0.90						
Common and braid, 44, 40, and 36s	: 1200F	1-1/4-inch cores	-	48s	31.95	8.95	82.65	17.35	-	17.35	-	0.20						
	:	Britch	1.17	40/36s-	36.50	13.02	64.10	35.90	-	35.90	-	4.50						
	:	Stained	0.54	46s	32.95	9.38	77.80	22.20	-	22.20	-	0.70						
	:	Top, skirted - N.	-	48s	32.93	9.00	75.90	24.10	-	24.10	-	0.30						
	:	Top, unskirted - N.	-	46s	34.10	9.15	73.40	26.60	-	26.60	-	0.40						

1/ Used to represent grease wool of the unskirted lot portion

2/ Fr. denotes wools were French combed.

3/ N. denotes wools were Noble combed.

4/ 36s minus denotes wool whose fineness variability exceeds the proposed specifications for this grade.

Table 2.--Analysis of variance for fineness, by visual grade classification

Source of variance	Lots: Fine, 64s and finer			Lots: 1/2 blood, 60s and finer		
	Degrees of	Mean		Degrees of	Mean	
	freedom	squares		freedom	squares	
Lots	5	<u>1</u> /837.2		3	<u>1</u> /1,623.2	
Portions	1	<u>2</u> /87.1		1	54.8	
Residual	7,193	21.0		6,395	35.1	
Total	7,199			6,399		

Source of variance	Lots: 3/8 blood, 56/58s			Lots: 1/4 blood, 48/50s		
	Degrees of	Mean		Degrees of	Mean	
	freedom	squares		freedom	squares	
Lots	3	<u>1</u> /2,775.1		2	<u>1</u> /9,409.0	
Portions	1	88.3		1	52.2	
Residual	7,995	47.2		5,996	65.9	
Total	7,999			5,999		

Source of variance	Lots: Low 1/4 blood, 46s			Lots: Common & braid, 44,40,36s		
	Degrees of	Mean		Degrees of	Mean	
	freedom	squares		freedom	squares	
Lots	2	<u>1</u> /7,376.3		-	-	
Portions	1	<u>1</u> /952.0		1	<u>1</u> /684.4	
Residual	5,996	78.3		1,998	82.4	
Total	5,999			1,999		

1/ Significant at the 0.1 percent probability level

2/ Significant at the 5 percent probability level

Table 3.--Length: C.C.C. grade classification, C.C.C. length classification, average length, standard deviation, coefficient of variation, maximum length, minimum length, range in length and percent stretch for 21 lots

C.C.C. grade classification	C.C.C. length classification	Lot number	Wool sample	Average length	Standard deviation	Coefficient of variation	Maximum length	Minimum length	Inches	Inches	Percent	Stretch
				Inches	Inches	Percent	Inches	Inches	Inches	Inches	Percent	Range
Fine, 64s and finer	Strictly staple	4-800-A1	Grease staples: Normal Stretched Top, skirted - Fr. 1/ Top, unskirted - Fr.	2.96 3.84 2.63 2.43	0.43 0.45 1.12 1.08	14.53 11.72 42.58 44.44	4.00 4.75 5.75 5.25	1.75 2.00 0.25 0.25	2.25 2.75 5.50 5.00		29.72	
Do.	Delaine	12100-1B	Grease staples: Normal Stretched Top, skirted - Fr. Top, unskirted - Fr.	2.61 3.33 2.71 2.61	0.47 0.57 1.06 1.05	18.01 17.18 39.11 40.23	4.00 4.50 5.75 5.25	1.50 2.00 0.25 0.25	2.50 2.50 5.50 5.00		27.58	
Do.	Staple and good French combing	4-1923-A2	Grease staples: Normal Stretched Top, skirted - Fr. Top, unskirted - Fr.	2.44 3.38 2.41 2.44	0.41 0.49 0.95 0.98	16.80 14.50 39.42 40.16	3.50 4.50 5.25 5.25	1.50 2.50 0.25 0.25	2.00 2.00 5.00 5.00		38.52	
Do.	Original bag, 12 months, good French combing and staple	M217	Grease staples: Normal Stretched Top, skirted - Fr. Top, unskirted - Fr.	2.24 2.98 2.51 2.50	0.45 0.56 0.93 0.99	20.29 18.79 37.05 39.60	3.25 4.25 5.25 5.25	1.25 1.75 0.25 0.25	2.00 2.50 5.00 5.00		33.03	
Do.	Original bag, 12 months, average to good French combing	Mc3-H2X	Grease staples: Normal Stretched Top, skirted - Fr. Top, unskirted - Fr.	2.18 2.95 2.28 2.39	0.48 0.56 0.93 0.96	22.00 18.93 40.79 40.17	3.50 4.50 4.75 5.25	1.25 2.25 0.25 0.25	2.25 2.25 4.50 5.00		35.32	
Do.	Original bag, 8 months, best length	N593	Grease staples: Normal Stretched Top, skirted - Fr. Top, unskirted - Fr.	2.42 3.20 2.63 2.63	0.56 0.77 1.00 0.99	23.14 24.06 38.02 37.64	4.50 5.75 5.25 5.25	1.25 1.75 0.25 0.25	3.25 4.00 5.00 5.00		32.23	

Continued--

1/ Fr. denotes wools were French combed

Table 3.--Length: C.C.C. grade classification, C.C.C. length classification, average length, standard deviation, coefficient of variation, maximum length, minimum length, range in length and percent stretch for 21 lots--continued

C.C.C. grade classification	C.C.C. length classification	Lot number	Wool sample	Average length	Standard deviation	Coefficient of variation	Maximum length	Minimum length	Inches	Inches	Percent	Stretch
1/2 blood, 60s and finer	Staple and good French combing	4-1658-B	Grease staples:									
			Normal	2.82	0.60	21.28	4.00	1.25	2.75	31.56		
			Stretched	3.71	0.62	16.71	5.00	2.25	2.75			
			Top, skirted - Fr.	2.43	1.11	45.68	5.75	0.25	5.50			
			Top, unskirted - Fr.	2.53	1.10	43.48	5.75	0.25	5.50			
Do.		G-516-1/2	Grease staples:									
			Normal	2.52	0.42	16.67	3.75	1.50	2.25	28.57		
			Stretched	3.24	0.50	15.43	4.50	2.00	2.50			
			Top, skirted - N. 2	2.64	0.98	37.12	5.75	0.25	5.50			
			Top, unskirted - N.	2.61	0.98	37.55	5.75	0.25	5.50			
Do.		2NC	Grease staples:									
			Normal	2.42	0.56	23.14	3.75	1.25	2.50	32.64		
			Stretched	3.21	0.65	20.25	4.50	1.75	2.75			
			Top, skirted - Fr.	2.67	1.01	37.83	5.25	0.25	5.00			
			Top, unskirted - Fr.	2.52	0.96	38.10	5.25	0.25	5.00			
Do.		2DB	Grease staples:									
			Normal	2.61	0.53	20.31	4.00	1.75	2.25	25.67		
			Stretched	3.28	0.63	19.21	5.00	2.00	3.00			
			Top, skirted - N.	3.06	1.04	33.99	5.75	0.25	5.50			
			Top, unskirted - N.	3.15	1.12	35.55	6.75	0.25	6.50			
3/8 blood, 56/58s	Staple and good French combing	4200-C	Grease staples:									
			Normal	2.79	0.62	22.22	4.25	1.25	3.00	36.55		
			Stretched	3.81	0.72	18.90	5.50	1.75	3.75			
			Top, skirted - N.	3.09	1.18	38.19	6.75	0.25	6.50			
			Top, unskirted - N.	3.04	1.13	37.17	6.25	0.25	6.00			
Do.		4UC	Grease staples:									
			Normal	2.78	0.54	19.42	4.00	7.25	2.75	25.53		
			Stretched	3.49	0.60	17.19	5.00	2.00	3.00			
			Top, skirted - N.	3.18	1.10	34.59	6.75	0.25	6.50			
			Top, unskirted - N.	3.23	1.14	35.29	6.75	0.25	6.50			

2/ N. denotes wools were Noble combed.

Continued--

Table 3.--Length: C.C.C. grade classification, C.C.C. length classification, average length, standard deviation, coefficient of variation, maximum length, minimum length, range in length and percent stretch for 21 lots--continued

C.C.C. grade classification	C.C.C. length classification	Lot number	Wool sample	Average length	Standard deviation	Coefficient of variation	Maximum length	Minimum length	Range	Stretch
				Inches	Inches	Percent	Inches	Inches	Inches	Percent
3/8 blood, 56/58s	Staple and good French combing	16860	Grease staples:							
			Normal	2.72	0.58	21.32	4.25	1.00	3.25	29.04
			Stretched	3.51	0.72	20.51	5.50	1.25	4.25	
			Top, skirted - N.	2.89	1.14	39.45	6.25	0.25	6.00	
			Top, unskirted - N.	2.96	1.15	38.85	6.25	0.25	6.00	
	Do.	93497	Grease staples:							
			Normal	3.09	0.68	22.01	4.50	1.25	3.25	23.94
			Stretched	3.83	0.69	18.02	5.75	2.00	3.75	
			Top, skirted - N.	3.57	1.41	39.50	7.25	0.25	7.00	
			Top, unskirted - N.	3.40	1.34	39.41	7.25	0.25	7.00	
1/4 blood, 48/50s	Staple and good French combing	113006	Grease staples:							
			Normal	3.02	0.68	22.52	5.75	1.75	4.00	34.10
			Stretched	4.05	0.87	21.48	6.50	2.25	4.25	
			Top, skirted - N.	3.49	1.29	36.96	7.25	0.25	7.00	
			Top, unskirted - N.	3.43	1.30	37.90	7.25	0.25	7.00	
	Do.	93494	Grease staples:							
			Normal	3.07	0.61	19.87	4.75	1.50	3.25	39.73
			Stretched	4.29	0.79	18.41	6.50	2.25	4.25	
			Top, skirted - N.	3.55	1.30	36.62	7.25	0.25	7.00	
			Top, unskirted - N.	3.51	1.29	36.75	7.25	0.25	7.00	
	Average French combing	93498	Grease staples:							
			Normal	3.55	0.86	24.23	7.00	1.50	5.50	23.94
			Stretched	4.40	0.96	21.82	7.50	2.00	5.50	
			Top, skirted - N.	3.64	1.55	42.58	7.75	0.25	7.50	
			Top, unskirted - N.	3.48	1.43	41.09	7.25	0.25	7.00	
Low 1/4 blood, 46s	Staple and good French combing	1014	Grease staples:							
			Normal	4.40	0.86	19.55	6.50	2.50	4.00	22.50
			Stretched	5.39	0.94	17.44	7.75	3.25	4.50	
			Top, skirted - N.	4.34	1.76	40.55	8.25	0.25	8.00	
			Top, unskirted - N.	4.55	1.76	32.68	8.25	0.25	8.00	

Continued--

Table 3.--Length: C.C.C. grade classification, C.C.C. length classification, average length, standard deviation, coefficient of variation, maximum length, minimum length, range in length and percent stretch for 21 lots--continued

C.C.C. grade classification	C.C.C. length classification	Lot number	Wool sample	Average length		Standard deviation		Coefficient of variation		Maximum length		Minimum length		Range		Stretch	
				Inches	Inches	Inches	Inches	Percent	Percent	Inches	Inches	Inches	Inches	Inches	Inches	Percent	Percent
Low 1/4 blood, 46s		93504	Grease staples:														
			Normal	4.39		1.00		22.78		8.00		2.75		5.25		25.28	
			Stretched	5.50		1.45		26.36		9.25		3.00		6.25			
			Top, skirted - N.	4.23		1.60		37.83		8.25		0.25		8.00			
			Top, unskirted - N.	4.24		1.64		38.68		8.75		0.25		8.50			
Do.		124015	Grease staples:														
			Normal	3.50		0.82		23.43		6.50		1.50		5.00		28.85	
			Stretched	4.51		0.96		21.28		7.75		2.25		5.50			
			Top, skirted - N.	3.85		1.53		39.74		8.25		0.25		8.00			
			Top, unskirted - N.	4.04		1.50		37.13		8.25		0.25		8.00			
Common and braid, 44, 40, and 36s		1200F	Grease staples:														
			Normal	4.46		0.86		19.28		6.75		2.50		4.25		23.09	
			Stretched	5.49		0.98		17.85		8.00		3.00		5.00			
			Top, skirted - N.	3.64		1.60		43.96		8.25		0.25		8.00			
			Top, unskirted - N.	3.61		1.62		44.88		8.25		0.25		8.00			

Table 4.--Correlation between various physical properties and characteristics of domestic wool

Dependent variable	Fineness:		Length		Staple crimp		Stretch:		Noilage		Yield		Color	
	: Average:	: r	: Average:	: r	: Average:	: r	: Percent:	: r	: Percent:	: r	: Top :	: r	: Yield :	: r
Length:														
Average normal length :	1/.76	-												
of grease wool staples :														
Average stretched length:	.87	.99												
of grease wool staples :														
Average fiber length of :		.87												
top, skirted portion :														
Average fiber length of :		.86												
top, unskirted portion :														
Staple crimp:														
Average number of crimps:	-.95	-.82												
per inch														
Crimp type index	.59	.70												
Stretch:														
Percent stretch of :	-.33	-.56												
grease wool staples :														
Noilage:														
Percent noilage, skirted:	-.72	-.71					.26							
portion														
Percent noilage,	-.70	-.69					.30							
unskirted portion														
Yield:														
Top yield, skirted	.92	.88					.57							
portion														
Top yield, unskirted	.93	.89					.59							
portion														
Top-noil-waste yield	.90	.85					.51							
Yield based on 1-1/4-	.91	.86					.52							
inch core sample														
Color:														
Color rating, skirted	-.77	-.73					.28							
top														
Color rating, unskirted:	-.70	-.64					.21							
top														

1/ r value of .433, significant at 5-percent probability level; r value of .549, significant at 1-percent probability level

Table 5.--Staple crimp: C.C.C. grade classification, number crimps per inch, crimp type and crimp type index for 21 lots

C.C.C.	:	:	Average	: Measured	:	:	:
grade	:	Lot	: number	: fineness	:	Crimp type	: Crimp
classifi-	:	number	: of crimps	: of grease	:	Bold	: Inter- : Dim
cation	:	:	: per inch	: wool	:	: mediate:	: type : index
	:			<u>Microns</u>	<u>Percent</u>	<u>Percent</u>	<u>Percent</u>
Fine, 64s	:	4-800-A1	15.4	23.05	1.4	50.0	48.6 152.8
and finer	:	12100-1B	15.0	21.05	2.9	65.7	31.4 171.5
	:	4-1923-A2	14.5	22.69	0	46.4	53.6 146.4
	:	M217	15.5	21.25	0	34.3	65.7 134.3
	:	Mc3-H2X	16.0	21.43	0	28.6	71.4 128.6
	:	N-593	14.9	21.25	0	35.7	64.3 135.7
	:						
1/2 blood,	:	4-1658-B	12.8	24.05	0	18.6	81.4 118.6
60s and	:	G-516-1/2	11.3	23.98	1.4	24.3	74.3 127.1
finer	:	2NC	12.3	23.30	0	27.1	72.9 127.1
	:	2DB	9.8	25.65	10.0	40.0	50.0 160.0
	:						
3/8 blood,	:	4200-C	9.1	26.30	3.3	36.7	60.0 143.3
56/58s	:	4 UC	8.0	27.69	0	37.5	62.5 137.5
	:	16860	9.6	25.83	1.7	5.8	92.5 109.2
	:	93497	9.2	27.23	3.3	38.3	58.4 144.9
	:						
1/4 blood,	:	113006	6.6	27.90	15.0	42.5	42.5 172.5
48/50s	:	93494	6.3	31.50	12.5	37.5	50.0 162.5
	:	93498	6.2	30.42	1.7	45.8	52.5 149.2
	:						
Low 1/4 blood	:	1014	4.1	30.85	35.0	44.2	20.8 214.2
46s	:	93504	3.9	35.34	25.8	42.5	31.7 194.1
	:	124015	4.6	34.25	14.2	47.5	38.3 175.9
	:						
Common and	:	1200F	4.2	31.95	1.7	57.5	40.8 160.9
braid,	:						
44,40,and 36s	:						
	:						

Table 6.--Yields: Core yields and various mill yields for 21 lots of wool by C.C.C. grade classification

C.C.C. grade classifi- cation	Lot number	Mill yields			Core yields	
		Scoured	Card sliver <u>1/</u>	Top-noil- waste <u>1/</u>	Original 1-1/4-inch	1-1/4-inch
		Percent	Percent	Percent	Percent	Percent
Fine, 64s and finer	:4-800-A-1	52.54	47.79	48.27	49.70	48.04
	:12100-1B	37.70	35.86	34.73	36.70	36.47
	:4-1923-A2	46.36	44.08	43.46	42.60	44.25
	:M-217	41.50	38.63	38.65	38.20	38.38
	:Mc3-H2X	39.69	37.73	36.38	36.00	36.97
	:N-593	43.72	42.74	41.51	40.20	42.42
	:Average	43.59	41.14	40.50	40.57	41.09
1/2 blood, 60s and finer	:4-1658-B	45.01	45.07	44.20	45.70	45.30
	:G-516-1/2	45.92	42.27	42.16	43.40	43.59
	:2NC	39.44	36.45	36.45	37.60	36.83
	:2DB	53.86	50.15	49.49	52.00	52.98
	:Average	46.06	43.49	43.08	44.68	44.68
3/8 blood, 56/58s	:4200-C	53.35	49.46	49.82	47.70	49.60
	:4UC	52.66	49.97	48.61	48.20	50.80
	:16860	48.41	45.42	45.26	44.80	46.00
	:93497	57.10	53.16	52.70	52.80	53.43
	:Average	52.88	49.50	49.10	48.38	49.96
1/4 blood, 48/50s	:113006	48.57	44.67	44.07	45.60	46.23
	:93494	62.06	57.90	58.90	59.50	59.30
	:93498	60.45	56.52	56.88	57.00	59.67
	:Average	57.03	53.02	53.28	54.03	55.07
Low 1/4 blood, 46s	:1014	58.49	56.32	56.24	54.10	56.89
	:93504	67.29	61.78	61.33	63.30	64.10
	:124015	61.46	59.11	58.70	59.60	60.21
	:Average	62.41	59.07	58.76	59.00	60.40
Common and braid, 44,40, and 36s	:1200F	69.35	65.94	66.49	66.00	67.82
	:Average					
	:21 lots	51.66	48.62	48.30	48.60	49.49

1/ Includes carding wastes

All yields adjusted to 14% impurities (12% moisture, 2% residuals) by weight

Table 7.--Wastes: Percent noil on top and noil, and standard clean wool in wastes expressed in percent of grease wool, by lot and by C.C.C. grade classification

C.C.C. grade classifi- cation	Lot number	Percent noil on top and noil	Standard clean wool in wastes, expressed in percent of grease wool:		
			All wastes including noil	All wastes except noil	Carding wastes only
Fine, 64s and finer	:4-800-A-1	12.8	7.9	2.1	1.5
	:12100-1B	11.8	6.0	2.2	1.7
	:4-1923-A2	12.8	7.7	2.5	1.9
	:M-217	12.7	6.7	2.1	1.5
	:Mc3-H2X	13.8	7.2	2.5	1.9
	:N-593	11.3	6.4	2.0	1.5
	:				
1/2 blood, 60s and finer	:4-1658-B	11.5	7.7	3.1	2.4
	:G-516-1/2	14.9	7.9	2.0	1.6
	:2NC	11.1	5.7	1.9	1.3
	:2DB	11.9	8.1	2.6	2.3
	:				
3/8 blood, 56/58s	:4200-C	14.0	8.9	2.4	1.8
	:4UC	11.6	8.0	2.7	2.2
	:16860	15.0	8.6	2.1	1.8
	:93497	11.4	7.9	2.4	1.9
	:				
1/4 blood, 48/50s	:113006	10.8	6.3	1.8	1.4
	:93494	9.7	8.1	2.7	2.1
	:93498	9.4	7.6	2.6	2.1
	:				
Low 1/4 blood, 46s	:1014	8.4	5.8	1.2	1.0
	:93504	7.3	6.3	2.1	1.8
	:124015	8.5	6.8	2.1	1.9
	:				
Common and braid, 44,40, and 36s	:1200F	10.7	9.4	2.6	1.9
	:				

Table 8.--Vegetable matter: Percent vegetable matter in grease wool, percent vegetable matter in card sliver and pieces of vegetable matter appearing in finished top, by lot

Lot number:	Description	Total vegetable matter percent in grease wool	Number pieces per ounce of top	Vegetable matter percent in card sliver
4-1658-B	:California, : 1/2 blood	5.30	25	0.24
2DB	:Belle Fourche, : 1/2 blood	4.60	21	0.18
4-800-A1	:California, fine	4.43	38	0.60
12100-1B	:Michigan Delaine	3.85	67	0.21
4UC	:Colorado, : 3/8 blood	3.30	18	0.11
93504	:New York, Low : 1/4 blood	2.80	39	0.37
Mc3-H2X	:Texas original : bag, fine	2.60	22	0.50
93494	:New York, choice : 1/4 blood	2.30	26	0.24
4-1923-2A	:California, fine	2.07	29	0.23
1200F	:California, common : and braid	2.00	15	0.39
124015	:Virginia, Low : 1/4 blood	2.00	29	0.08
113006	:Wyoming, Bright : 1/4 blood	2.00	20	0.11
93497	:New York, Bright : 3/8 blood	1.90	45	0.30
93498	:New York, Bright : 1/4 blood	1.90	37	0.28
16860	:Idaho, 3/8 blood	1.80	17	0.13
1014	:Idaho, Low : 1/4 blood	1.30	29	0.21
M217	:Texas original bag, : fine	1.09	15	0.14
4-200-C	:California, : 3/8 blood	1.01	23	0.60
G-516-1/2	:Idaho, 1/2 blood	0.96	23	0.30
2NC	:Nevada, 1/2 blood	0.80	15	0.29
N-593	:Texas original bag, : fine	0.50	13	0.10

Table 9.--Top yield and noilage: Top yield and noilage for skirted and unskirted portions by lot and C.C.C. grade classification

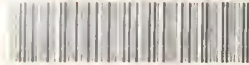
C.C.C. grade classification	Lot number	Top yield		Noilage	
		Skirted portion	Unskirted portion	Skirted portion	Unskirted portion
		Percent	Percent	Percent	Percent
Fine, 64s and finer	4-800-A1	40.3	40.0	12.8	12.8
	12100-1B	28.4	29.1	11.5	12.0
	4-1923-A2	36.0	35.6	12.7	12.9
	M217	32.0	31.8	13.2	12.1
	Mc3-H2X	29.1	29.3	13.9	13.8
	N-593	34.6	35.3	11.2	11.4
1/2 blood, 60s and finer	4-1658-B	36.5	36.2	11.8	11.3
	G-516-1/2	34.3	34.0	14.8	15.1
	2NC	31.1	30.4	10.4	11.8
	2DB	41.9	40.5	11.9	12.0
3/8 blood, 56/58s	4200-C	41.7	39.9	13.4	14.5
	4UC	40.3	41.1	11.7	11.4
	16860	36.1	37.2	14.7	15.4
	93497	44.6	44.6	11.0	11.8
1/4 blood, 48/50s	113006	37.6	38.0	10.6	11.1
	93494	51.6	50.1	9.4	10.1
	93498	50.3	48.5	9.4	9.4
Low 1/4 blood 46s	1014	50.4	50.5	8.4	8.4
	93504	55.6	54.3	7.3	7.3
	124015	51.7	51.9	8.9	8.2
Common and braid, 44,40, and 36s	1200F	57.6	56.6	10.6	10.8

Table 10.--Color: Ratings for color estimated by using a wool color comparator, by sample and by lot

C.C.C. grade classification	Lot number	Color ratings by sample:									
		Scoured : core : sample	Scoured : britch : wool	Scoured : stained : wool	Skirted : portion	Unskirted : portion	Skirted : portion	Unskirted : portion	Card sliver : Skirted : portion	Card sliver : Unskirted : portion	Top : Skirted : portion
Fine, 64s and finer	4-800-A1	C	C	E- 1/	C	B	C	C	C	C	C
	12100-1B	B	-	E-	B	B	B	B	B	B	B
	4-1923-A2	B	-	E-	B	B	B	B	B	B	B
	M217	B	B	-	B	A	A	A	A	A	A
	Mc3-H2X	A	C	E-	A	B	A	B	B	A	B
	N593	A	B	-	A	A	A	A	A	A	A
1/2 blood, 60s and finer	4-1658-B	C	B	E-	B	B	B	B	B	C	B
	G-516-1/2	B	B	E-	B	B	A	A	A	A	A
	2NC	C	D	E	C	B	B	C	C	C	C
	2DB	A	B	E-	A	B	A	A	A	A	A
3/8 blood, 56/58s	4200-C	C	C	E-	B	C	C	D	C	C	C
	4UC	A	B	E-	B	A	A	A	A	B	A
	16860	B	B	E	C	B	B	B	B	B	B
	93497	E	E	E-	E	D	E	E	E	E	E
1/4 blood, 48/50s	113006	B	C	E-	A	B	A	A	A	B	B
	93494	E	E	E-	D	E	D	D	D	D	E
	93498	E	E	E-	E	E	E	E	E	E	E
Low 1/4 blood, 46s	1014	C	C	E-	B	C	C	C	C	C	C
	93504	E	E	E-	D	D	D	D	D	E	D
	124015	E	E	E-	D	D	D	D	D	E	E
Common and braid 44,40, and 26s	1200F	D	D	E-	D	D	E	E	E	E	E

1/ E- indicates a darker color than the comparator example

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